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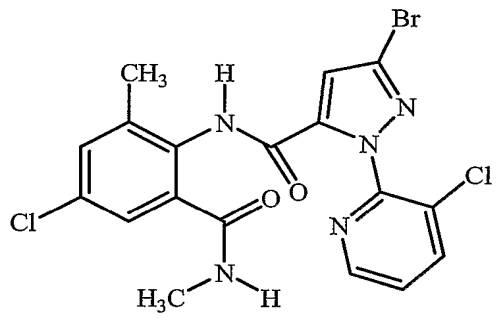

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(57) Abstract: Disclosed are mixtures and compositions for controlling invertebrate pests relating to combinations comprising (a) 3-bromo-*N*-[4-chloro-2-methyl-6-[(methylamino)carbonyl]phenyl]-1-(3-chloro-2-pyridinyl)-1*H*-*pyrazole*-5-carboxamide, and its *N* oxides, and suitable salts thereof and a component (b) wherein the component (b) is at least one compound or agent selected from neonicotinoids, cholinesterase inhibitors, sodium channel modulators, chitin synthesis inhibitors, ecdysone agonists, lipid biosynthesis inhibitors, macrocyclic lactones, GABA-regulated chloride channel blockers, juvenile hormone mimics, ryanodine receptor ligands, octopamine receptor ligands, mitochondrial electron transport inhibitors, nereistoxin analogs, pyridalyl, flonicamid, pymetrozine, dieldrin, metaflumizone, biological agents, and suitable salts of the foregoing. Also disclosed are methods for controlling an invertebrate pest comprising contacting the invertebrate pest or its environment with a biologically effective amount of a mixture or composition of the invention.

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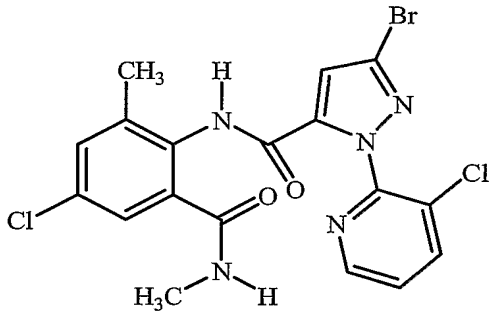
TITLE

SYNERGISTIC MIXTURES OF ANTHRANILAMIDE INVERTEBRATE PEST CONTROL AGENTS

ABSTRACT OF THE DISCLOSURE

Disclosed are mixtures and compositions for controlling invertebrate pests relating to combinations comprising (a) 3-bromo-*N*-[4-chloro-2-methyl-6-[(methylamino)carbonyl]phenyl]-1-(3-chloro-2-pyridinyl)-1*H*-pyrazole-5-carboxamide, and its *N*-oxides, and suitable salts thereof



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and

a component (b) wherein the component (b) is at least one compound or agent selected from neonicotinoids, cholinesterase inhibitors, sodium channel modulators, chitin synthesis inhibitors, ecdysone agonists, lipid biosynthesis inhibitors, macrocyclic lactones, GABA-regulated chloride channel blockers, juvenile hormone mimics, ryanodine receptor ligands, octopamine receptor ligands, mitochondrial electron transport inhibitors, nereistoxin analogs, pyridalyl, flonicamid, pymetrozine, dieldrin, metaflumizone, biological agents, and suitable salts of the foregoing.

Also disclosed are methods for controlling an invertebrate pest comprising contacting the invertebrate pest or its environment with a biologically effective amount of a mixture or composition of the invention.

TITLE

SYNERGISTIC MIXTURES OF ANTHRANILAMIDE INVERTEBRATE PEST CONTROL AGENTS

FIELD OF THE INVENTION

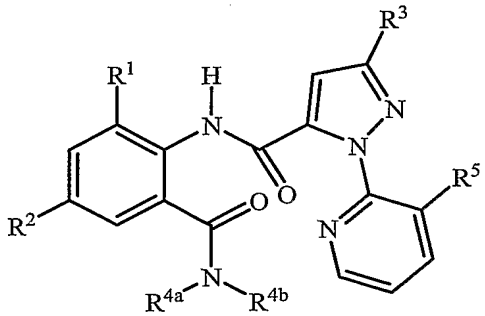
This invention relates to invertebrate pest control mixtures comprising a biologically effective amount of an anthranilamide, an *N*-oxide or a salt thereof and at least one other invertebrate pest control agent, and methods of their use for control of invertebrate pests such as arthropods in both agronomic and non-agronomic environments.

BACKGROUND OF THE INVENTION

The control of invertebrate pests is extremely important in achieving high crop efficiency. Damage by invertebrate pests to growing and stored agronomic crops can cause significant reduction in productivity and thereby result in increased costs to the consumer. The control of invertebrate pests in forestry, greenhouse crops, ornamentals, nursery crops, stored food and fiber products, livestock, household, turf, wood products, and public and animal health is also important. Many products are commercially available for these purposes and in practice have been used as a single or a mixed agent. However, more economically efficient and ecologically safe pest control compositions and methods are still being sought.

Being able to reduce the quantity of chemical agents released in the environment while ensuring effective pest control is always desirable. Although combinations of pest control agents have been studied, a high synergistic action is generally not found. Synergism has been described as "the cooperative action of two components of a mixture, such that the total effect is greater or more prolonged than the sum of the effects of the two (or more) taken independently" (see P. M. L. Yames, *Neth. J. Plant Pathology* **1964**, 70, 73-80). Therefore, obtaining an arthropodicidal composition that demonstrates a high controlling effect with concomitant reduced crop production cost and reduced environmental load is highly desirable.

WO 03/015519 discloses *N*-acyl anthranilic acid derivatives of Formula i as arthropodicides

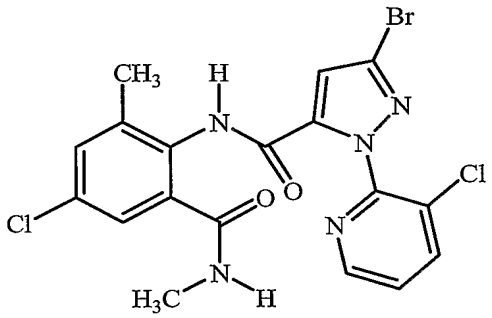


i

wherein, *inter alia*, R^1 is CH_3, F, Cl or Br; R^2 is F, Cl, Br, I or CF_3; R^3 is CF_3, Cl, Br or OCH_2CF_3; R^{4a} is C_1-C_4 alkyl; R^{4b} is H or CH_3; and R^5 is Cl or Br.

SUMMARY OF THE INVENTION

This invention is directed to a mixture comprising (a) a compound of Formula 1, 3-bromo-*N*-[4-chloro-2-methyl-6-[(methylamino)carbonyl]phenyl]-1-(3-chloro-2-pyridinyl)-1*H*-pyrazole-5-carboxamide, an *N*-oxide, or a salt thereof,



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and

a component (b) wherein the component (b) is at least one invertebrate pest control agent selected from the group consisting of

(b1) neonicotinoids;

(b2) cholinesterase inhibitors;

(b3) sodium channel modulators;

(b4) chitin synthesis inhibitors;

(b5) ecdysone agonists;

(b6) lipid biosynthesis inhibitors;

(b7) macrocyclic lactones;

(b8) GABA-regulated chloride channel blockers;

(b9) juvenile hormone mimics;

(b10) ryanodine receptor ligands;

(b11) octopamine receptor ligands;

(b12) mitochondrial electron transport inhibitors;

(b13) nereistoxin analogs;

(b14) pyridalyl;

(b15) flonicamid;

(b16) pymetrozine;

(b17) dieldrin;

(b18) metaflumizone;

(b19) biological agents; and

salts of compounds of (b1) through (b18).

This invention also provides a composition for controlling an invertebrate pest comprising a biologically effective amount of a mixture of the invention and at least one additional component selected from the group consisting of a surfactant, a solid diluent and a liquid diluent, said composition optionally further comprising an effective amount of at least one additional biologically active compound or agent.

This invention also provides a method for controlling an invertebrate pest comprising contacting the invertebrate pest or its environment with a biologically effective amount of a mixture or composition of the invention, as described herein.

This invention further provides a spray composition comprising a mixture of the invention and a propellant. This invention also provides a bait composition comprising a mixture of the invention; one or more food materials; optionally an attractant; and optionally a humectant.

This invention further provides a trap device for controlling an invertebrate pest comprising said bait composition and a housing adapted to receive said bait composition, wherein the housing has at least one opening sized to permit the invertebrate pest to pass through the opening so the invertebrate pest can gain access to said bait composition from a location outside the housing, and wherein the housing is further adapted to be placed in or near a locus of potential or known activity for the invertebrate pest.

DETAILS OF THE INVENTION

As used herein, the terms "comprises," "comprising," "includes," "including," "has," "having" or any other variation thereof, are intended to cover a non-exclusive inclusion. For example, a composition, a mixture, process, method, article, or apparatus that comprises a list of elements is not necessarily limited to only those elements but may include other elements not expressly listed or inherent to such composition, mixture, process, method, article, or apparatus. Further, unless expressly stated to the contrary, "or" refers to an inclusive or and not to an exclusive or. For example, a condition A or B is satisfied by any one of the following: A is true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

Also, use of "a" or "an" are employed to describe elements and components of the invention. This is done merely for convenience and to give a general sense of the invention. This description should be read to include one or at least one and the singular also includes the plural unless it is obvious that it is meant otherwise.

Compounds in the mixtures and compositions of this invention can exist as one or more stereoisomers. The various stereoisomers include enantiomers, diastereomers, atropisomers and geometric isomers. One skilled in the art will appreciate that one stereoisomer may be more active and/or may exhibit beneficial effects when enriched

relative to the other stereoisomer(s) or when separated from the other stereoisomer(s). Additionally, the skilled artisan knows how to separate, enrich, and/or to selectively prepare said stereoisomers. Accordingly, the present invention comprises a mixture comprising a compound of Formula 1, an *N*-oxide, or a salt thereof, said compound of Formula 1, an *N*-oxide, or a salt thereof also referred to herein as "component (a)"; and at least one invertebrate pest control agent which can be a compound (or a salt thereof) selected from (b1) through (b18) or a biological agent selected from (b19) and is also referred to herein as "component (b)". Compositions of the present invention can optionally include at least one additional biologically active compound or agent, which if present in a composition will differ from the compound of Formula 1 and the component (b). These additional biologically active compounds or agents including insecticides, fungicides, nematicides, bactericides, acaricides, growth regulators such as rooting stimulants, chemosterilants, semiochemicals, repellents, attractants, pheromones, feeding stimulants, other biologically active compounds or entomopathogenic bacteria, virus or fungi to form a multi-component pesticide giving an even broader spectrum of agricultural or nonagronomic utility. These additional biologically active compounds or agents can be present as a mixture of stereoisomers, individual stereoisomers, or as an optically active form.

Salts of compounds in the mixtures and compositions of the present invention include acid-addition salts with inorganic or organic acids such as hydrobromic, hydrochloric, nitric, phosphoric, sulfuric, acetic, butyric, fumaric, lactic, maleic, malonic, oxalic, propionic, salicylic, tartaric, 4-toluenesulfonic or valeric acids. Salts of the compounds of the invention also include those formed with organic bases (e.g., pyridine or triethylamine) or inorganic bases (e.g., hydrides, hydroxides, or carbonates of sodium, potassium, lithium, calcium, magnesium or barium) when the compound contains an acidic group such as a carboxylic acid or phenol.

Embodiments of the present invention include:

Embodiment 1. A mixture comprising a component (a) and a component (b) wherein the component (a) is a compound of Formula 1, an *N*-oxide, or a salt thereof.

Embodiment 2. The mixture of Embodiment 1 wherein the component (b) is at least one pest control agent selected from the group consisting of (b1) neonicotinoids, (b2) cholinesterase inhibitors and (b3) sodium channel modulators.

Embodiment 3. The mixture of Embodiment 1 wherein the component (b) is a compound selected from (b1) neonicotinoids.

Embodiment 4. The mixture of Embodiment 3 wherein the component (b) is selected from the group consisting of pyridylmethylamines such as acetamiprid

and thiacloprid; nitromethylenes such as nitenpyram and nithiazine; and nitroguanidines such as clothianidin, dinotefuran, imidacloprid and thiamethoxam.

Embodiment 5. The mixture of Embodiment 4 wherein the component (b) is dinotefuran, imidacloprid, nitenpyram, thiacloprid or thiamethoxam.

Embodiment 5a. The mixture of Embodiment 4 wherein the component (b) is dinotefuran.

Embodiment 5b. The mixture of Embodiment 5 wherein the component (b) is imidacloprid.

Embodiment 5c. The mixture of Embodiment 5 wherein the component (b) is nitenpyram.

Embodiment 5d. The mixture of Embodiment 5 wherein the component (b) is thiacloprid.

Embodiment 5e. The mixture of Embodiment 5 wherein the component (b) is thiamethoxam.

Embodiment 6. The mixture of Embodiment 1 wherein the component (b) is a compound selected from (b2) cholinesterase inhibitors.

Embodiment 7. The mixture of Embodiment 6 wherein the component (b) is selected from the group consisting of organophosphates such as acephate, azinphos-methyl, chlorethoxyfos, chlorprazophos, chlorpyrifos, chlorpyrifos-methyl, coumaphos, cyanofenphos, demeton-S-methyl, diazinon, dichlorvos, dimethoate, dioxabenzofos, disulfoton, dithicrofos, fenamiphos, fenitrothion, fonofos, isofenphos, isoxathion, malathion, methamidophos, methidathion, mipafox, monocrotophos, oxydemeton-methyl, parathion, parathion-methyl, phorate, phosalone, phosmet, phosphamidon, phoxim, pirimiphos-methyl, profenofos, pyraclofos, quinalphos-methyl, sulprofos, temephos, terbufos, tetrachlorvinphos, thicrofos, triazophos, and trichlofon; and carbamates such as aldicarb, aldoxycarb, bendiocarb, benfuracarb, butocarboxim, carbaryl, carbofuran, carbosulfan, ethiofencarb, furathiocarb, methiocarb, methomyl (Lannate®), oxamyl (Vydate®), pirimicarb, propoxur, thiodicarb, triazamate and xylylcarb.

Embodiment 8. The mixture of Embodiment 7 wherein the component (b) is methomyl or oxamyl.

Embodiment 8a. The mixture of Embodiment 8 wherein the component (b) is methomyl.

Embodiment 8b. The mixture of Embodiment 8 wherein the component (b) is oxamyl.

Embodiment 9. The mixture of Embodiment 1 wherein the component (b) is a compound selected from (b3) sodium channel modulators.

Embodiment 10. The mixture of Embodiment 9 wherein the component (b) is selected from the group consisting of pyrethroids such as allethrin, alpha-cypermethrin, beta-cyfluthrin, beta-cypermethrin, bifenthrin, cyfluthrin, cyhalothrin, cypermethrin, deltamethrin, esfenvalerate, fenfluthrin, fenpropathrin, fenvalerate, flucythrinate, gamma-cyhalothrin, lambda-cyhalothrin, metofluthrin, permethrin, profluthrin, resmethrin, tau-fluvalinate, tefluthrin, tetramethrin, tralomethrin, transfluthrin and zeta-cypermethrin; non-ester pyrethroids such as etofenprox, flufenprox, halfenprox, protrifenbute and silafluofen; oxadiazines such as indoxacarb; and natural pyrethrins such as cinerin-I, cinerin-II, jasmolin-I, jasmolin-II, pyrethrin-I and pyrethrin-II.

Embodiment 11. The mixture of Embodiment 10 wherein the component (b) is deltamethrin, indoxacarb or lambda-cyhalothrin.

Embodiment 11a. The mixture of Embodiment 11 wherein the component (b) is deltamethrin.

Embodiment 11b. The mixture of Embodiment 11 wherein the component (b) is indoxacarb.

Embodiment 11c. The mixture of Embodiment 11 wherein the component (b) is lambda-cyhalothrin.

Embodiment 12. The mixture of Embodiment 1 wherein the component (b) is a compound selected from (b4) chitin synthesis inhibitors.

Embodiment 13. The mixture of Embodiment 12 wherein the component (b) is selected from the group consisting of bistrifluron, buprofezin, chlorfluazuron, cyromazine, diflubenzuron, flucycloxuron, flufenoxuron, hexaflumuron, lufenuron, novaluron, noviflumuron, penfluron, teflubenzuron and triflumuron.

Embodiment 14. The mixture of Embodiment 13 wherein the component (b) is hexaflumuron or novaluron.

Embodiment 14a. The mixture of Embodiment 14 wherein the component (b) is hexaflumuron.

Embodiment 14b. The mixture of Embodiment 14 wherein the component (b) is novaluron.

Embodiment 15. The mixture of Embodiment 1 wherein the component (b) is a compound selected from (b5) ecdysone agonists.

Embodiment 16. The mixture of Embodiment 15 wherein the component (b) is selected from the group consisting of azadirachtin, chromafenozide, halofenozide, methoxyfenozide and tebufenozide.

Embodiment 17. The mixture of Embodiment 1 wherein the component (b) is a compound selected from (b6) lipid biosynthesis inhibitors.

Embodiment 18. The mixture of Embodiment 17 wherein the component (b) is spiromesifen or spiridiclofen.

Embodiment 19. The mixture of Embodiment 1 wherein the component (b) is a compound selected from (b7) macrocyclic lactones.

Embodiment 20. The mixture of Embodiment 19 wherein the component (b) is selected from the group consisting of spinosad, abamectin, avermectin, doramectin, emamectin, eprinomectin, ivermectin, milbemectin, milbemycin oxime, moxidectin, nemadectin and selamectin.

Embodiment 21. The mixture of Embodiment 20 wherein the component (b) is spinosad or abamectin.

Embodiment 21a. The mixture of Embodiment 21 wherein the component (b) is spinosad.

Embodiment 21b. The mixture of Embodiment 21 wherein the component (b) is abamectin.

Embodiment 22. The mixture of Embodiment 1 wherein the component (b) is a compound selected from (b8) GABA-regulated chloride channel blockers.

Embodiment 23. The mixture of Embodiment 22 wherein the component (b) is selected from the group consisting of acetoprole, endosulfan, ethiprole, fipronil and vaniliprole.

Embodiment 24. The mixture of Embodiment 23 wherein the component (b) is fipronil.

Embodiment 25. The mixture of Embodiment 1 wherein the component (b) is a compound selected from (b9) juvenile hormone mimics.

Embodiment 26. The mixture of Embodiment 25 wherein the component (b) is selected from the group consisting of epofenonane, fenoxycarb, hydroprene, kinoprene, methoprene, pyriproxyfen and triprene.

Embodiment 27. The mixture of Embodiment 26 wherein the component (b) is fenoxycarb or methoprene.

Embodiment 27a. The mixture of Embodiment 27 wherein the component (b) is fenoxycarb.

Embodiment 27b. The mixture of Embodiment 27 wherein the component (b) is methoprene.

Embodiment 28. The mixture of Embodiment 1 wherein the component (b) is a compound selected from (b10) ryanodine receptor ligands.

Embodiment 29. The mixture of Embodiment 28 wherein the component (b) is selected from the group consisting of ryanodine and other products of *Ryania*

speciosa Vahl. (Flacourtiaceae) which are ryanodine receptor ligands, anthranilamides and phthalic diamides such as flubendiamide.

Embodiment 30. The mixture of Embodiment 1 wherein the component (b) is a compound selected from (b11) octopamine receptor ligands.

Embodiment 31. The mixture of Embodiment 30 wherein the component (b) is amitraz or chlordimeform.

Embodiment 31a. The mixture of Embodiment 31 wherein the component (b) is amitraz.

Embodiment 32. The mixture of Embodiment 1 wherein the component (b) is a compound selected from (b12) mitochondrial electron transport inhibitors.

Embodiment 33. The mixture of Embodiment 32 wherein the component (b) is selected from the group consisting of acequinocyl, chlofenapyr, diafenthiuron, dicofol, fenazaquin, fenpyroximate, hydramethylnon, pyridaben, rotenone, tebufenpyrad and tolfenpyrad.

Embodiment 34. The mixture of Embodiment 34 wherein the component (b) is chlofenapyr, hydramethylnon or pyridaben.

Embodiment 34a. The mixture of Embodiment 34 wherein the component (b) is chlofenapyr.

Embodiment 34b. The mixture of Embodiment 34 wherein component (b) is hydramethylnon.

Embodiment 34c. The mixture of Embodiment 34 wherein component (b) is pyridaben.

Embodiment 35. The mixture of Embodiment 1 wherein the component (b) is a compound selected from (b13) nereistoxin analogs.

Embodiment 36. The mixture of Embodiment 35 wherein the component (b) is selected from the group consisting of bensultap, cartap, thiocyclam and thiosultap.

Embodiment 37. The mixture of Embodiment 36 wherein the component (b) is cartap.

Embodiment 38. The mixture of Embodiment 1 wherein the component (b) is pyridalyl.

Embodiment 39. The mixture of Embodiment 1 wherein the component (b) is flonicamid.

Embodiment 40. The mixture of Embodiment 1 wherein the component (b) is pymetrozine.

Embodiment 41. The mixture of Embodiment 1 wherein the component (b) is dieldrin.

Embodiment 42. The mixture of Embodiment 1 wherein the component (b) is metaflumizone.

Embodiment 43. The mixture of Embodiment 1 wherein the component (b) is an agent selected from (b19) biological agents.

Embodiment 44. The mixture of Embodiment 43 wherein the component (b) is selected from the group consisting of *Bacillus thuringiensis* ssp. *aizawai*, *Bacillus thuringiensis* ssp. *kurstaki*, *Bacillus thuringiensis* encapsulated delta-endotoxins, *Beauvaria bassiana*, granulosis virus (CpGV and CmGV) and nuclear polyhedrosis virus (NPV, e.g., "Gemstar").

Embodiment 45. The mixture of Embodiment 1 wherein the component (b) is a compound selected from dinotefuran, imidacloprid, nitenpyram, thiacloprid, thiamethoxam, methomyl, oxamyl, deltamethrin, indoxacarb, lambda-cyhalothrin, hexaflumuron, novaluron, abamectin, spinosad, fipronil, fenoxycarb, methoprene, amitraz, chlofenapyr, hydramethylnon, pyridaben, cartap, flonicamid, pymetrozine and dieldrin.

Embodiment 46. The mixture of Embodiment 1 wherein the component (b) comprises at least one invertebrate pest control agent from each of two different groups selected from (b1), (b2), (b3), (b4), (b5), (b6), (b7), (b8), (b9), (b10), (b11), (b12), (b13), (b14), (b15), (b16), (b17), (b18) and (b19) and wherein any compound selected from any of groups (b1) through (b18) may be in a salt form.

Also noteworthy as embodiments are arthropodicidal compositions of the present invention comprising a biologically effective amount of a mixture of Embodiments 1 to 46 and at least one additional component selected from the group consisting of a surfactant, a solid diluent, a liquid diluent, and optionally at least one additional biologically active compound or agent. Embodiments of the invention further include methods for controlling an invertebrate pest comprising contacting the invertebrate pest or its environment with a biologically effective amount of a mixture of any of Embodiments 1 to 46 (e.g., as a composition described herein). Of note is a method comprising contacting the invertebrate pest or its environment with a biologically effective amount of the mixture of Embodiment 1-4, 6, 7, 9, 10, 15-20, 22, 23, 25, 26, 28-33, 35, 36, 38-45 or 46.

Embodiments of the invention also include a spray composition comprising a mixture of any of Embodiments 1 to 46 and a propellant. Of note is a spray composition comprising the mixture of Embodiment 1-4, 6, 7, 9, 10, 15-20, 22, 23, 25, 26, 28-33, 35, 36, 38-45 or 46. Embodiments of the invention further include a bait composition comprising a mixture of any of Embodiments 1 to 46; one or more food materials; optionally an attractant; and optionally a humectant. Of note is a bait composition comprising the mixture of Embodiment 1-4, 6, 7, 9, 10, 15-20, 22, 23, 25, 26, 28-33, 35, 36, 38-45 or 46.

Embodiments of the invention also include a device for controlling an invertebrate pest comprising said bait composition and a housing adapted to receive said bait composition,

wherein the housing has at least one opening sized to permit the invertebrate pest to pass through the opening so the invertebrate pest can gain access to said bait composition from a location outside the housing, and wherein the housing is further adapted to be placed in or near a locus of potential or known activity for the invertebrate pest. Of note is a device wherein the bait composition comprises the mixture of Embodiment 1-4, 6, 7, 9, 10, 15-20, 22, 23, 25, 26, 28-33, 35, 36, 38-45 or 46.

The compound of Formula 1 can be prepared by one or more of the methods and variations thereof as described in World Patent Application Publication WO 03/015519. Synthetic methods for the preparation of *N*-oxides of heterocycles and tertiary amines are very well known by one skilled in the art including the oxidation of heterocycles and tertiary amines with peroxy acids such as peracetic and *m*-chloroperbenzoic acid (MCPBA), hydrogen peroxide, alkyl hydroperoxides such as *t*-butyl hydroperoxide, sodium perborate, and dioxiranes such as dimethydioxirane. These methods for the preparation of *N*-oxides have been extensively described and reviewed in the literature, see for example: T. L. Gilchrist in *Comprehensive Organic Synthesis*, vol. 7, pp 748-750, S. V. Ley, Ed., Pergamon Press; M. Tisler and B. Stanovnik in *Comprehensive Heterocyclic Chemistry*, vol. 3, pp 18-20, A. J. Boulton and A. McKillop, Eds., Pergamon Press; M. R. Grimmett and B. R. T. Keene in *Advances in Heterocyclic Chemistry*, vol. 43, pp 149-161, A. R. Katritzky, Ed., Academic Press; M. Tisler and B. Stanovnik in *Advances in Heterocyclic Chemistry*, vol. 9, pp 285-291, A. R. Katritzky and A. J. Boulton, Eds., Academic Press; and G. W. H. Cheeseman and E. S. G. Werstiuk in *Advances in Heterocyclic Chemistry*, vol. 22, pp 390-392, A. R. Katritzky and A. J. Boulton, Eds., Academic Press.

The invertebrate pest control agent of groups (b1), (b2), (b3), (b4), (b5), (b6), (b7), (b8), (b9), (b10), (b11), (b12), (b13), (b14), (b15), (b16), (b17) and (b18) have been described in published patents and scientific journal papers. Most of the compounds of groups (b1) through (b18) and the biological agents of group (b19) are commercially available as active ingredients in invertebrate pest control products. These compounds and biological agents are described in compendia such as *The Pesticide Manual, 13th edition.*, C. D. S. Thomlin (Ed.), British Crop Protection Council, Surrey, UK, 2003. Certain of these groups are further described below.

Neonicotinoids (group (b1))

All neonicotinoids act as agonists at the nicotinic acetylcholine receptor in the central nervous system of insects. This causes excitation of the nerves and eventual paralysis, which leads to death. Due to the mode of action of neonicotinoids, there is no cross-resistance to conventional insecticide classes such as carbamates, organophosphates, and pyrethroids. A review of the neonicotinoids is described in *Pestology* **2003**, *27*, pp 60-63; *Annual Review of Entomology* **2003**, *48*, pp 339-364; and references cited therein.

Neonicotinoids act as acute contact and stomach poisons, combine systemic properties with relatively low application rates, and are relatively nontoxic to vertebrates. There are many compounds in this group including the pyridylmethylamines such as acetamiprid and thiacloprid; nitromethylenes such as nitenpyram and nithiazine; nitroguanidines such as clothianidin, dinotefuran, imidacloprid and thiamethoxam.

Cholinesterase Inhibitors (group (b2))

Two chemical classes of compounds are known to inhibit the cholinesterase; one is the organophosphates and the other is the carbamates. Organophosphates involve phosphorylation of the enzyme, while carbamates involve a reversible carbamylation of the enzyme. The organophosphates include acephate, azinphos-methyl, chlorethoxyfos, chlorprazophos, chlorpyrifos, chlorpyrifos-methyl, coumaphos, cyanofenphos, demeton-S-methyl, diazinon, dichlorvos, dimethoate, dioxabenzofos, disulfoton, dithicrofos, fenamiphos, fenitrothion, fonofos, isofenphos, isoxathion, malathion, methamidophos, methidathion, mipafox, monocrotophos, oxydemeton-methyl, parathion, parathion-methyl, phorate, phosalone, phosmet, phosphamidon, phoxim, pirimiphos-methyl, profenofos, pyraclofos, quinalphos-methyl, sulprofos, temephos, terbufos, tetrachlorvinphos, thicrofos, triazophos, and trichlofon. The carbamates include aldicarb, aldoxycarb, bendiocarb, benfuracarb, butocarboxim, carbaryl, carbofuran, carbosulfan, ethiofencarb, furathiocarb, methiocarb, methomyl (Lannate®), oxamyl (Vydate®), pirimicarb, propoxur, thiodicarb, triazamate and xylylcarb. A general review of the mode of action of insecticides is presented in *Insecticides with Novel Modes of Action: Mechanism and Application*, I. Ishaaya, et al (Ed.), Springer:Berlin, 1998.

Sodium Channel Modulators (group (b3))

Insecticidal compounds acting as sodium channel modulators disrupt the normal functioning of voltage-dependent sodium channels in insects, which causes rapid paralysis or knock-down following application of these insecticides. Reviews of insecticides targeting nerve membrane sodium channels are presented in, for example, *Toxicology* **2002**, *171*, pp 3-59; *Pest Management Sci.* **2001**, *57*, pp 153-164; and references cited therein. The sodium channel modulators have been grouped together based on their chemical structural similarity into four classes, including pyrethroids, non-ester pyrethroids, oxidiazines and natural pyrethrins. The pyrethroids include allethrin, alpha-cypermethrin, beta-cyfluthrin, beta-cypermethrin, bifenthrin, cyfluthrin, cyhalothrin, cypermethrin, deltamethrin, esfenvalerate, fenfluthrin, fenpropathrin, fenvalerate, flucythrinate, gamma-cyhalothrin, lambda-cyhalothrin, metofluthrin, permethrin, profluthrin, resmethrin, tau-fluvalinate, tefluthrin, tetramethrin, tralomethrin, transfluthrin and zeta-cypermethrin. The non-ester pyrethroids include etofenprox, flufenprox, halfenprox, protrifenbute and silafluofen. The oxadiazines include indoxacarb. The natural pyrethrins include cinerin-I, cinerin-II, jasmolin-I, jasmolin-II, pyrethrin-I and pyrethrin-II.

Other Insecticide Groups

Chitin synthesis inhibitors (b4) include bistrifluron, buprofezin, chlorfluazuron, cyromazine, diflubenzuron, flucycloxuron, flufenoxuron, hexaflumuron, lufenuron, novaluron, noviflumuron, penfluron, teflubenzuron and triflumuron.

Ecdysone agonists (b5) include azadirachtin, chromafenozide, halofenozide, methoxyfenozide and tebufenozide.

Lipid biosynthesis inhibitors (b6) include spiromesifen and spiridiclofen.

Macrocyclic lactones (b7) include spinosad, abamectin, avermectin, doramectin, emamectin, eprinomectin, ivermectin, milbemectin, milbemycin oxime, moxidectin, nemadectin and selamectin.

GABA-regulated chloride channel blockers (b8) include acetoprole, endosulfan, ethiprole, fipronil and vaniliprole.

Juvenile hormone mimics (b9) include epofenonane, fenoxycarb, hydroprene, methoprene, pyriproxyfen and triprene.

Ryanodine receptor ligands (b10) include ryanodine and other related products of *Ryania speciosa* Vahl. (Flacourtiaceae), anthranilamides other than the compound of Formula 1 and phthalic diamides (disclosed in JP-A-11-240857 and JP-A-2001-131141) such as flubendiamide.

Octopamine receptor ligands (b11) include amitraz and chlordimeform.

Mitochondrial electron transport inhibitors (b12) include ligands which bind to complex I, II, or III sites to inhibit cellular respiration. Such mitochondrial electron transport inhibitors include acequinocyl, chlorfenapyr, diafenthiuron, dicofol, fenazaquin, fenpyroximate, hydramethylnon, pyridaben, rotenone, tebufenpyrad and tolfenpyrad.

Nereistoxin analogs (b13) include bensultap, cartap, thiocyclam and thiosultap.

Biological agents (b19) include entomopathogenic bacteria such as *Bacillus thuringiensis* ssp. *aizawai*, *Bacillus thuringiensis* ssp. *kurstaki*, *Bacillus thuringiensis* encapsulated delta-endotoxins, entomopathogenic fungi such as *Beauvaria bassiana*, and entomopathogenic viruses such as granulosis virus (CpGV and CmGV) and nuclear polyhedrosis virus (NPV, e.g., "Gemstar").

Other Insecticides, Acaricides, Nematicides

There are many known insecticides, acaricides and nematicides as disclosed in *The Pesticide Manual 13th Ed.* 2003 including those whose mode of action is not yet clearly defined and those which are a single compound class including amidoflumet (S-1955), bifenazate, chlorofenmidine, dieldrin, diofenolan, fenothiocarb, flufenerim (UR-50701), metaldehyde, metaflumizone (BASF-320), methoxychlor; bactericides such as streptomycin; acaricides such as chinomethionat, chlorobenzilate, cyhexatin, dienochlor, etoxazole, fenbutatin oxide, hexythiazox and propargite.

The weight ratios of component (b) to the compound of Formula 1, an *N*-oxide, or a salt thereof in the mixtures, compositions and methods of the present invention are typically from 150:1 to 1:200, preferably from 150:1 to 1:50, more preferably from 50:1 to 1:10 and most preferably from 5:1 to 1:5. Of note are mixtures, compositions and methods wherein component (b) is a compound selected from (b1) neonicotinoids and the weight ratio of component (b) to the compound of Formula 1, an *N*-oxide, or a salt thereof is from 150:1 to 1:200. Also of note are mixtures, compositions and methods wherein component (b) is a compound selected from (b2) cholinesterase inhibitors and the weight ratio of component (b) to the compound of Formula 1, an *N*-oxide, or a salt thereof is from 200:1 to 1:100. Also of note are mixtures, compositions and methods wherein component (b) is a compound selected from (b3) sodium channel modulators and the weight ratio of component (b) to the compound of Formula 1, an *N*-oxide, or a salt thereof is from 100:1 to 1:10.

Of further note are mixtures, compositions and methods of the present invention wherein component (b) is a compound selected from (b1) neonicotinoids and the weight ratio of component (b) to the compound of Formula 1, an *N*-oxide, or a salt thereof, is from 10:1 to 1:50. Also of note are mixtures, compositions and methods of the present invention wherein component (b) is a compound of (b2) cholinesterase inhibitors and the weight ratio of component (b) to the compound of Formula 1, an *N*-oxide, or a salt thereof, is from 150:1 to 1:25. Of further note are mixtures, composition and methods of the present invention wherein component (b) is a compound of (b3) sodium channel modulators and the weight ratio of component (b) to the compound of Formula 1, an *N*-oxide, or a salt thereof, is from 50:1 to 1:5.

Of note are mixtures, compositions and methods wherein component (b) comprises at least one compound (or a salt thereof) or biological agent from each of two different groups selected from (b1), (b2), (b3), (b4), (b5), (b6), (b7), (b8), (b9), (b10), (b11), (b12), (b13), (b14), (b15), (b16), (b17), (b18) and (b19).

Table 1 lists specific combinations of the compound of Formula 1 with other invertebrate pest control agents illustrative of the mixtures, compositions and methods of the present invention. The first column of Table 1 lists the group to which the component (b) belongs (e.g., "b1" in the first line). The second column of Table 1 lists specific invertebrate pest control agents (e.g., "Acetamiprid" in the first line). The third column of Table 1 lists atypical range of weight ratios of rates at which component (b) is applied relative to the compound of Formula 1 (e.g., "150:1 to 1:200" of acetamiprid relative to the compound of Formula 1 by weight). The fourth and fifth columns respectively list one embodiment of a weight ratio range and another embodiment of a weight ratio range for applications rates. Thus, for example, the first line of Table 1 specifically discloses the combination of the compound of Formula 1 with acetamiprid, identifies that acetamiprid is a member of component (b) group (b1), and indicates that acetamiprid and the compound of Formula 1

are typically applied in a weight ratio between 150:1 to 1:200, with one embodiment being 10:1 to 1:100 and another embodiment being 5:1 to 1:25. The remaining lines of Table 1 are to be construed similarly.

Table 1

Component (b)	Invertebrate Pest Control Agent	Typical Weight Ratio	Preferred Weight Ratio	More Preferred Weight Ratio
b1	Acetamiprid	150:1 to 1:200	10:1 to 1:100	5:1 to 1:25
b1	Clothianidin	100:1 to 1:400	10:1 to 1:25	5:1 to 1:5
b1	Dinotefuran	150:1 to 1:500	10:1 to 1:100	5:1 to 1:25
b1	Imidacloprid	100:1 to 1:400	10:1 to 1:25	5:1 to 1:10
b1	Nitenpyram	150:1 to 1:200	10:1 to 1:50	5:1 to 1:25
b1	Nithiazine	150:1 to 1:200	10:1 to 1:50	5:1 to 1:25
b1	Thiacloprid	100:1 to 1:250	15:1 to 1:30	5:1 to 1:5
b1	Thiamethoxam	150:1 to 1:500	20:1 to 1:50	5:1 to 1:10
b2	Methomyl	100:1 to 1:50	50:1 to 1:25	5:1 to 1:10
b2	Oxamyl	100:1 to 1:50	50:1 to 1:10	5:1 to 1:1
b2	Thiodicarb	200:1 to 1:100	150:1 to 1:25	50:1 to 1:5
b2	Triazamate	200:1 to 1:100	150:1 to 1:25	50:1 to 1:5
b3	Bifenthrin	100:1 to 1:10	50:1 to 1:5	10:1 to 1:1
b3	Deltamethrin	50:1 to 1:500	25:1 to 1:50	10:1 to 1:10
b3	Esfenvalerate	100:1 to 1:10	50:1 to 1:5	5:1 to 1:1
b3	Indoxacarb	100:1 to 1:100	25:1 to 1:25	10:1 to 1:10
b3	Lambda-cyhalothrin	50:1 to 1:10	25:1 to 1:5	5:1 to 1:1
b3	Pyrethrin	100:1 to 1:10	50:1 to 1:5	5:1 to 1:1
b4	Buprofezin	200:1 to 1:150	100:1 to 1:50	50:1 to 1:5
b4	Cyromazine	200:1 to 1:150	100:1 to 1:50	50:1 to 1:5
b4	Hexaflumuron	200:1 to 1:150	100:1 to 1:10	50:1 to 1:1
b4	Lufenuron	200:1 to 1:150	100:1 to 1:50	50:1 to 1:5
b4	Novaluron	250:1 to 1:150	100:1 to 1:10	50:1 to 1:1
b5	Azadirachtin	100:1 to 1:120	20:1 to 1:10	1:1 to 1:5
b5	Methoxyfenozide	50:1 to 1:750	25:1 to 1:250	1:1 to 1:100
b5	Tebufenozide	50:1 to 1:250	25:1 to 1:150	1:1 to 1:25
b6	Spiridiclofen	200:1 to 1:200	20:1 to 1:20	10:1 to 1:10
b6	Spiromesifen	200:1 to 1:200	20:1 to 1:20	10:1 to 1:10
b7	Abamectin	50:1 to 1:500	25:1 to 1:250	5:1 to 1:100
b7	Emamectin Benzoate	50:1 to 1:10	25:1 to 1:5	5:1 to 1:1
b7	Spinosad	50:1 to 1:10	25:1 to 1:5	5:1 to 1:1

Component (b)	Invertebrate Pest Control Agent	Typical Weight Ratio	Preferred Weight Ratio	More Preferred Weight Ratio
b8	Fipronil	50:1 to 1:100	25:1 to 1:50	5:1 to 1:25
b9	Fenoxycarb	250:1 to 1:100	150:1 to 1:50	50:1 to 1:10
b9	Methoprene	500:1 to 1:100	250:1 to 1:50	50:1 to 1:10
b9	Pyriproxyfen	200:1 to 1:100	100:1 to 1:50	50:1 to 1:10
b10	Anthranilamide	100:1 to 1:200	20:1 to 1:100	1:1 to 1:50
b10	Flubendiamide	100:1 to 1:200	20:1 to 1:100	1:1 to 1:50
b10	Ryanodine	100:1 to 1:120	20:1 to 1:10	1:1 to 1:5
b11	Amitraz	250:1 to 1:100	100:1 to 1:50	25:1 to 1:10
b12	Chlorfenapyr	1200:1 to 1:200	400:1 to 1:100	200:1 to 1:50
b12	Hydramethylnon	100:1 to 1:500	20:1 to 1:100	1:1 to 1:10
b12	Pyridaben	200:1 to 1:100	100:1 to 1:50	50:1 to 1:10
b13	Cartap	100:1 to 1:1000	50:1 to 1:500	5:1 to 1:100
b14	Pyridalyl	200:1 to 1:100	100:1 to 1:50	50:1 to 1:10
b15	Flonicamid	20:1 to 1:500	15:1 to 1:250	5:1 to 1:50
b16	Pymetrozine	200:1 to 1:500	150:1 to 1:250	50:1 to 1:50
b17	Dieldrin	200:1 to 1:500	100:1 to 1:100	25:1 to 1:50
b18	Metaflumizone	200:1 to 1:200	100:1 to 1:100	20:1 to 1:20
b19	*Bacillus thuringiensis*	50:1 to 1:10	25:1 to 1:5	5:1 to 1:1
b19	*Beauvaria bassiana*	50:1 to 1:10	25:1 to 1:5	5:1 to 1:1
b19	NPV (e.g., Gemstar)	50:1 to 1:10	25:1 to 1:5	5:1 to 1:1

Of note are mixtures and compositions of this invention that can also be mixed with one or more other biologically active compounds or agents including insecticides, fungicides, nematicides, bactericides, acaricides, growth regulators such as rooting stimulants, chemosterilants, semiochemicals, repellents, attractants, pheromones, feeding stimulants, other biologically active compounds or entomopathogenic bacteria, virus or fungi to form a multi-component pesticide giving an even broader spectrum of agricultural or nonagronomic utility. Thus the present invention also pertains to a mixture or a composition comprising a biologically effective amount of a compound of Formula 1, an *N*-oxide thereof, or an agronomic or nonagronomic suitable salt thereof (component (a)); an effective amount of at least one additional biologically active compound (or salt thereof) or agent selected from the group consisting of (b1), (b2), (b3), (b4), (b5), (b6), (b7), (b8), (b9), (b10), (b11), (b12), (b13), (b14), (b15), (b16), (b17), (b18), (b19) (component (b)); and can further comprise at least one of a surfactant, a solid diluent or a liquid diluent and optionally further comprise an effective amount of at least one additional biologically active compound or agent. Such optionally biologically active compound(s) or agent(s) if present with the

mixtures and compositions of this invention will differ from the components (a) and (b), said additional biologically active compound(s) or agent(s) can be an insecticide, an acaricide, a nematicide or a fungicide. Examples of an insecticide include a compound (or salt thereof) selected from the group consisting of amidoflumet (S-1955), bifenazate, chlorofenmidine, diofenolan, fenothiocarb, flufenerim (UR-50701), metaldehyde, methoxychlor; and examples of fungicides including acibenzolar-S-methyl, azoxystrobin, benalazy-M, benthiavalicarb, benomyl, blasticidin-S, Bordeaux mixture (tribasic copper sulfate), boscalid, bromuconazole, buthiobate, carpropamid, captafol, captan, carbendazim, chloroneb, chlorothalonil, clotrimazole, copper oxychloride, copper salts, cymoxanil, cyazofamid, cyflufenamid, cyproconazole, cyprodinil, diclocymet, diclomezine, dicloran, difenoconazole, dimethomorph, dimoxystrobin, diniconazole, diniconazole-M, dodine, edifenphos, epoxiconazole, ethaboxam, famoxadone, fenarimol, fenbuconazole, fenhexamid, fenoxanil, fenpiclonil, fenpropidin, fenpropimorph, fentin acetate, fentin hydroxide, fluazinam, fludioxonil, flumorph, fluoxastrobin, fluquinconazole, flusilazole, flutolanil, flutriafol, folpet, fosetyl-aluminum, furalaxyl, furametapyr, guazatine, hexaconazole, hymexazol, imazalil, imibenconazole, iminoctadine, ipconazole, iprobenfos, iprodione, iprovalicarb, isoconazole, isoprothiolane, kasugamycin, kresoxim-methyl, mancozeb, maneb, mefenoxam, mepanapyrim, mepronil, metalaxyl, metconazole, metominostrobin/fenominostrobin, metrafenone, miconazole, myclobutanil, neo-asozin (ferric methanearsonate), nuarimol, oryzastrobin, oxadixyl, oxpoconazole, penconazole, pencycuron, picobenzamid, picoxystrobin, probenazole, prochloraz, propamocarb, propiconazole, proquinazid, prothioconazole, pyraclostrobin, pyrimethanil, pyrifenox, pyroquilon, quinoxyfen, silthiofam, simeconazole, sipconazole, spiroxamine, sulfur, tebuconazole, tetraconazole, tiadinil, thiabendazole, thifluzamide, thiophanate-methyl, thiram, tolylfluanid, triadimefon, triadimenol, triarimol, tricyclazole, trifloxystrobin, triflumizole, triforine, triticonazole, uniconazole, validamycin, vinclozolin and zoxamide. Compositions of this invention can be applied to plants genetically transformed to express proteins toxic to invertebrate pests (such as *Bacillus thuringiensis* toxin). The effect of the exogenously applied invertebrate pest control compounds of this invention may be synergistic with the expressed toxin proteins.

The weight ratios of these various mixing partners to the compound of Formula 1, an *N*-oxide or a salt thereof of this invention typically are between 200:1 and 1:150, with one embodiment being between 150:1 and 1:50, another embodiment being between 50:1 and 1:10 and another embodiment being between 5:1 and 1:5.

The mixtures and compositions of this invention are useful to control invertebrate pests. In certain instances, combinations with other invertebrate pest control active ingredients having a similar spectrum of control but a different mode of action will be particularly advantageous for resistance management.

Formulation/Utility

Mixtures of this invention can generally be used as a formulation or composition with a carrier suitable for agronomic and nonagronomic uses comprising at least one of a liquid diluent, a solid diluent or a surfactant. The formulation, mixture or composition ingredients can be selected to be consistent with the physical properties of the active ingredients, mode of application and environmental factors such as soil type, moisture and temperature. Useful formulations include liquids such as solutions (including emulsifiable concentrates), suspensions, emulsions (including microemulsions and/or suspoemulsions) and the like which optionally can be thickened into gels. Useful formulations further include solids such as dusts, powders, granules, pellets, tablets, films (including seed treatment), and the like which can be water-dispersible ("wettable") or water-soluble. Active ingredient can be (micro)encapsulated and further formed into a suspension or solid formulation; alternatively the entire formulation of active ingredient can be encapsulated (or "overcoated"). Encapsulation can control or delay release of the active ingredient. Compositions of the invention can also optionally comprise plant nutrients, e.g. a fertilizer composition comprising at least one plant nutrient selected from nitrogen, phosphorus, potassium, sulfur, calcium, magnesium, iron, copper, boron, manganese, zinc, and molybdenum. Of note are compositions comprising at least one fertilizer composition comprising at least one plant nutrient selected from nitrogen, phosphorus, potassium, sulfur, calcium and magnesium. Compositions of the present invention which further comprise at least one plant nutrient can be in the form of liquids or solids. Of note are solid formulations in the form of granules, small sticks or tablets. Solid formulations comprising a fertilizer composition can be prepared by mixing the mixture or composition of the present invention with the fertilizer composition together with formulating ingredients and then preparing the formulation by methods such as granulation or extrusion. Alternatively solid formulations can be prepared by spraying a solution or suspension of a mixture or composition of the present invention in a volatile solvent onto a previous prepared fertilizer composition in the form of dimensionally stable mixtures, e.g., granules, small sticks or tablets, and then evaporating the solvent. Sprayable formulations can be extended in suitable media and used at spray volumes from about one to several hundred liters per hectare. High-strength compositions can be primarily used as intermediates for further formulation.

The formulations will typically contain effective amounts of active ingredient, diluent and surfactant within the following approximate ranges which add up to 100 percent by weight.

	Weight Percent		
	Active Ingredients	Diluent	Surfactant
Water-Dispersible and Water-soluble Granules, Tablets and Powders.	0.001–90	0–99.999	0–15
Suspensions, Emulsions, Solutions (including Emulsifiable Concentrates)	1–50	40–99	0–50
Dusts	1–25	70–99	0–5
Granules and Pellets	0.001–99	5–99.999	0–15
High Strength Compositions	90–99	0–10	0–2

Typical solid diluents are described in Watkins, et al., *Handbook of Insecticide Dust Diluents and Carriers*, 2nd Ed., Dorland Books, Caldwell, New Jersey. Typical liquid diluents are described in Marsden, *Solvents Guide*, 2nd Ed., Interscience, New York, 1950. *McCutcheon's Detergents and Emulsifiers Annual*, Allured Publ. Corp., Ridgewood, New Jersey, as well as Sisely and Wood, *Encyclopedia of Surface Active Agents*, Chemical Publ. Co., Inc., New York, 1964, list surfactants and recommended uses. All formulations can contain minor amounts of additives to reduce foam, caking, corrosion, microbiological growth and the like, or thickeners to increase viscosity.

Surfactants include, for example, polyethoxylated alcohols, polyethoxylated alkylphenols, polyethoxylated sorbitan fatty acid esters, dialkyl sulfosuccinates, alkyl sulfates, alkylbenzene sulfonates, organosilicones, *N,N*-dialkyltaurates, lignin sulfonates, naphthalene sulfonate formaldehyde condensates, polycarboxylates, glycerol esters, polyoxyethylene/polyoxypropylene block copolymers, and alkylpolyglycosides where the number of glucose units, referred to as degree of polymerization (D.P.), can range from 1 to 3 and the alkyl units can range from C_6–C_{14} (see *Pure and Applied Chemistry 72*, 1255–1264). Solid diluents include, for example, clays such as bentonite, montmorillonite, attapulgite and kaolin, starch, sugar, silica, talc, diatomaceous earth, urea, calcium carbonate, sodium carbonate and bicarbonate, and sodium sulfate. Liquid diluents include, for example, water, *N,N*-dimethylformamide, dimethyl sulfoxide, *N*-alkylpyrrolidone, ethylene glycol, polypropylene glycol, paraffins, alkylbenzenes, alkylnaphthalenes, glycerine, triacetine, oils of olive, castor, linseed, tung, sesame, corn, peanut, cotton-seed, soybean, rape-seed and coconut, fatty acid esters, ketones such as cyclohexanone, 2-heptanone, isophorone and 4-hydroxy-4-methyl-2-pentanone, acetates and alcohols such as methanol, cyclohexanol, decanol and tetrahydrofurfuryl alcohol.

Useful formulations of this invention can also contain materials known as formulation aids including antifoams, film formers and dyes and are well known to those skilled in the art.

Antifoams can include water dispersible liquids comprising polyorganosiloxanes such as Rhodorsil® 416. The film formers can include polyvinyl acetates, polyvinyl acetate copolymers, polyvinylpyrrolidone-vinyl acetate copolymer, polyvinyl alcohols, polyvinyl

alcohol copolymers and waxes. Dyes can include water dispersible liquid colorant compositions such as Pro-lzed® Colorant Red. One skilled in the art will appreciate that this is a non-exhaustive list of formulation aids. Suitable examples of formulation aids include those listed herein and those listed in McCutcheon's 2001, Volume 2: Functional Materials, published by MC Publishing Company and PCT Publication WO 03/024222.

Solutions, including emulsifiable concentrates, can be prepared by simply mixing the ingredients. Dusts and powders can be prepared by blending and, usually, grinding as in a hammer mill or fluid-energy mill. Suspensions are usually prepared by wet-milling; see, for example, U.S. 3,060,084. Granules and pellets can be prepared by spraying the active material upon preformed granular carriers or by agglomeration techniques. See Browning, "Agglomeration", *Chemical Engineering*, December 4, 1967, pp 147-48, *Perry's Chemical Engineer's Handbook*, 4th Ed., McGraw-Hill, New York, 1963, pages 8-57 and following, and WO 91/13546. Pellets can be prepared as described in U.S. 4,172,714. Water-dispersible and water-soluble granules can be prepared as taught in U.S. 4,144,050, U.S. 3,920,442 and DE 3,246,493. Tablets can be prepared as taught in U.S. 5,180,587, U.S. 5,232,701 and U.S. 5,208,030. Films can be prepared as taught in GB 2,095,558 and U.S. 3,299,566.

For further information regarding the art of formulation, see U.S. 3,235,361, Col. 6, line 16 through Col. 7, line 19 and Examples 10-41; U.S. 3,309,192, Col. 5, line 43 through Col. 7, line 62 and Examples 8, 12, 15, 39, 41, 52, 53, 58, 132, 138-140, 162-164, 166, 167 and 169-182; U.S. 2,891,855, Col. 3, line 66 through Col. 5, line 17 and Examples 1-4; Klingman, *Weed Control as a Science*, John Wiley and Sons, Inc., New York, 1961, pp 81-96; and Hance et al., *Weed Control Handbook*, 8th Ed., Blackwell Scientific Publications, Oxford, 1989; *Developments in formulation technology,* PJB Publications, Richmond, UK, 2000.

In the following Examples, all percentages are by weight and all formulations are prepared in conventional ways. "Active ingredients" refers to the aggregate of invertebrate pest control agents consisting of component (b) in combination with the compound of Formula 1, an *N*-oxide or salt thereof. Without further elaboration, it is believed that one skilled in the art using the preceding description can utilize the present invention to its fullest extent. The following Examples are, therefore, to be constructed as merely illustrative, and not limiting of the disclosure in any way whatsoever. Percentages are by weight except where otherwise indicated.

Example A

Wettable Powder	
active ingredients	65.0%
dodecylphenol polyethylene glycol ether	2.0%
sodium ligninsulfonate	4.0%
sodium silicoaluminate	6.0%
montmorillonite (calcined)	23.0%

Example B

Granule	
active ingredients	10.0%
attapulgite granules (low volatile matter, 0.71/0.30 mm; U.S.S. No. 25–50 sieves)	90.0%

Example C

Extruded Pellet	
active ingredients	25.0%
anhydrous sodium sulfate	10.0%
crude calcium ligninsulfonate	5.0%
sodium alkylnaphthalenesulfonate	1.0%
calcium/magnesium bentonite	50.0%

Example D

Emulsifiable Concentrate	
active ingredients	20.0%
blend of oil soluble sulfonates and polyoxyethylene ethers	10.0%
isophorone	70.0%

Example E

Microemulsion	
active ingredients	5.0%
polyvinylpyrrolidone-vinyl acetate copolymer	30.0%
alkylpolyglycoside	30.0%
glyceryl monooleate	15.0%
water	20.0%

Example F

Seed Treatment	
active ingredients	20.00%
polyvinylpyrrolidone-vinyl acetate copolymer	5.00%
montan acid wax	5.00%
calcium ligninsulfonate	1.00%
polyoxyethylene/polyoxypropylene block copolymers	2.00%

stearyl alcohol (POE 20)	0.20%
polyorganosilane	0.05%
colorant red dye	65.75%
water	

Example G

Fertilizer Stick

active ingredients	2.50%
pyrrolidone-styrene copolymer	4.80%
tristyrylphenyl 16-ethoxylate	2.30%
talc	0.80%
corn starch	5.00%
Nitrophoska® Permanent 15-9-15 slow-release fertilizer (BASF)	36.00%
kaolin	38.00%
water	10.60%

Compositions and mixtures of this invention are characterized by favorable metabolic and/or soil residual patterns and exhibit activity controlling a spectrum of agronomic and non-agronomic invertebrate pests. (In the context of this disclosure "invertebrate pest control" means inhibition of invertebrate pest development (including mortality) that causes significant reduction in feeding or other injury or damage caused by the pest; related expressions are defined analogously.) As referred to in this disclosure, the term "invertebrate pest" includes arthropods, gastropods and nematodes of economic importance as pests. The term "arthropod" includes insects, mites, spiders, scorpions, centipedes, millipedes, pill bugs and symphylans. The term "gastropod" includes snails, slugs and other Stylommatophora. The term "nematode" includes all of the helminths, such as: roundworms, heartworms, and phytophagous nematodes (Nematoda), flukes (Tematoda), Acanthocephala, and tapeworms (Cestoda). Those skilled in the art will recognize that not all compositions or mixtures are equally effective against all pests. Compositions and mixtures of this invention display activity against economically important agronomic and nonagronomic pests. The term "agronomic" refers to the production of field crops such as for food and fiber and includes the growth of corn, soybeans and other legumes, rice, cereal (e.g., wheat, oats, barley, rye, rice, maize), leafy vegetables (e.g., lettuce, cabbage, and other cole crops), fruiting vegetables (e.g., tomatoes, pepper, eggplant, crucifers and cucurbits), potatoes, sweet potatoes, grapes, cotton, tree fruits (e.g., pome, stone and citrus), small fruit (berries, cherries) and other specialty crops (e.g., canola, sunflower, olives). The term "nonagronomic" refers to other horticultural crops (e.g., greenhouse, nursery or ornamental plants not grown in a field), residential and commercial structures in urban and industrial settings, turf (commercial, golf, residential, recreational, etc.), wood products, stored product

agro-forestry and vegetation management, public health (human) and animal health (pets, livestock, poultry, non-domesticated animals such as nature animals) applications. For reasons of invertebrate pest control spectrum and economic importance, protection of agronomic crops from damage or injury caused by invertebrate pests by controlling invertebrate pests are embodiments of the invention.

Agronomic or nonagronomic pests include larvae of the order Lepidoptera, such as armyworms, cutworms, loopers, and heliothines in the family Noctuidae (e.g., fall armyworm (*Spodoptera fugiperda* J. E. Smith), beet armyworm (*Spodoptera exigua* Hübner), black cutworm (*Agrotis ipsilon* Hufnagel), cabbage looper (*Trichoplusia ni* Hübner), tobacco budworm (*Heliothis virescens* Fabricius)); borers, casebearers, webworms, coneworms, cabbageworms and skeletonizers from the family Pyralidae (e.g., European corn borer (*Ostrinia nubilalis* Hübner), navel orangeworm (*Amyelois transitella* Walker), corn root webworm (*Crambus caliginosellus* Clemens), sod webworms (Pyralidae: *Crambinae*) such as sod webworm (*Herpetogramma licarsisalis* Walker)); leafrollers, budworms, seed worms, and fruit worms in the family Tortricidae (e.g., codling moth (*Cydia pomonella* Linnaeus), grape berry moth (*Endopiza viteana* Clemens), oriental fruit moth (*Grapholita molesta* Busck)); and many other economically important lepidoptera (e.g., diamondback moth (*Plutella xylostella* Linnaeus), pink bollworm (*Pectinophora gossypiella* Saunders), gypsy moth (*Lymantria dispar* Linnaeus)); nymphs and adults of the order Blattodea including cockroaches from the families Blattellidae and Blattidae (e.g., oriental cockroach (*Blatta orientalis* Linnaeus), Asian cockroach (*Blatella asahinai* Mizukubo), German cockroach (*Blattella germanica* Linnaeus), brownbanded cockroach (*Supella longipalpa* Fabricius), American cockroach (*Periplaneta americana* Linnaeus), brown cockroach (*Periplaneta brunnea* Burmeister), Madeira cockroach (*Leucophaea maderae* Fabricius), smoky brown cockroach (*Periplaneta fuliginosa* Service), Australian Cockroach (*Periplaneta australasiae* Fabr.), lobster cockroach (*Nauphoeta cinerea* Olivier) and smooth cockroach (*Symploce pallens* Stephens)); foliar feeding larvae and adults of the order Coleoptera including weevils from the families Anthribidae, Bruchidae, and Curculionidae (e.g., boll weevil (*Anthonomus grandis* Boheman), rice water weevil (*Lissorhoptrus oryzophilus* Kuschel), granary weevil (*Sitophilus granarius* Linnaeus), rice weevil (*Sitophilus oryzae* Linnaeus), annual bluegrass weevil (*Listronotus maculicollis* Dietz), bluegrass billbug (*Sphenophorus parvulus* Gyllenhal), hunting billbug (*Sphenophorus venatus vestitus*), Denver billbug (*Sphenophorus cicatristriatus* Fahraeus)); flea beetles, cucumber beetles, rootworms, leaf beetles, potato beetles, and leafminers in the family Chrysomelidae (e.g., Colorado potato beetle (*Leptinotarsa decemlineata* Say), western corn rootworm (*Diabrotica virgifera virgifera* LeConte)); chafers and other beetles from the family Scaribaeidae (e.g., Japanese beetle (*Popillia japonica* Newman), oriental beetle (*Anomala orientalis* Waterhouse), northern masked chafer (*Cyclocephala borealis* Arrow),

southern masked chafer (*Cyclocephala immaculata* Olivier), black turfgrass ataenius (*Ataenius spretulus* Haldeman), green June beetle (*Cotinis nitida* Linnaeus), Asiatic garden beetle (*Maladera castanea* Arrow), May/June beetles (*Phyllophaga* spp.) and European chafer (*Rhizotrogus majalis* Razoumowsky)); carpet beetles from the family Dermestidae; wireworms from the family Elateridae; bark beetles from the family Scolytidae and flour beetles from the family Tenebrionidae. In addition, agronomic and nonagronomic pests include: adults and larvae of the order Dermaptera including earwigs from the family Forficulidae (e.g., European earwig (*Forficula auricularia* Linnaeus), black earwig (*Chelisoches morio* Fabricius)); adults and nymphs of the orders Hemiptera and Homoptera such as, plant bugs from the family Miridae, cicadas from the family Cicadidae, leafhoppers (e.g. *Empoasca* spp.) from the family Cicadellidae, planthoppers from the families Fulgoroidae and Delphacidae, treehoppers from the family Membracidae, psyllids from the family Psyllidae, whiteflies from the family Aleyrodidae, aphids from the family Aphididae, phylloxera from the family Phylloxeridae, mealybugs from the family Pseudococcidae, scales from the families Coccidae, Diaspididae and Margarodidae, lace bugs from the family Tingidae, stink bugs from the family Pentatomidae, chinch bugs (e.g., hairy chinch bug (*Blissus leucopterus hirtus* Montandon) and southern chinch bug (*Blissus insularis* Barber)) and other seed bugs from the family Lygaeidae, spittlebugs from the family Cercopidae squash bugs from the family Coreidae, and red bugs and cotton stainers from the family Pyrrhocoridae. Also included are adults and larvae of the order Acari (mites) such as spider mites and red mites in the family Tetranychidae (e.g., European red mite (*Panonychus ulmi* Koch), two spotted spider mite (*Tetranychus urticae* Koch), McDaniel mite (*Tetranychus mcdanieli* McGregor)); flat mites in the family Tenuipalpidae (e.g., citrus flat mite (*Brevipalpus lewisi* McGregor)); rust and bud mites in the family Eriophyidae and other foliar feeding mites and mites important in human and animal health, i.e. dust mites in the family Epidermoptidae, follicle mites in the family Demodicidae, grain mites in the family Glycyphagidae, ticks in the order Ixodidae (e.g., deer tick (*Ixodes scapularis* Say), Australian paralysis tick (*Ixodes holocyclus* Neumann), American dog tick (*Dermacentor variabilis* Say), lone star tick (*Amblyomma americanum* Linnaeus)) and scab and itch mites in the families Psoroptidae, Pyemotidae, and Sarcoptidae; adults and immatures of the order Orthoptera including grasshoppers, locusts and crickets (e.g., migratory grasshoppers (e.g., *Melanoplus sanguinipes* Fabricius, *M. differentialis* Thomas), American grasshoppers (e.g., *Schistocerca americana* Drury), desert locust (*Schistocerca gregaria* Forskal), migratory locust (*Locusta migratoria* Linnaeus), bush locust (*Zonocerus* spp.), house cricket (*Acheta domesticus* Linnaeus), mole crickets (e.g., tawny mole cricket (*Scapteriscus vicinus* Scudder) and southern mole cricket (*Scapteriscus borellii* Giglio-Tos)); adults and immatures of the order Diptera including leafminers, midges, fruit flies (Tephritidae), frit flies (e.g., *Oscinella frit* Linnaeus), soil maggots, house flies (e.g., *Musca domestica* Linnaeus), lesser house flies

(e.g., *Fannia canicularis* Linnaeus, *F. femoralis* Stein), stable flies (e.g., *Stomoxys calcitrans* Linnaeus), face flies, horn flies, blow flies (e.g., *Chrysomya* spp., *Phormia* spp.), and other muscoid fly pests, horse flies (e.g., *Tabanus* spp.), bot flies (e.g., *Gastrophilus* spp., *Oestrus* spp.), cattle grubs (e.g., *Hypoderma* spp.), deer flies (e.g., *Chrysops* spp.), keds (e.g., *Melophagus ovinus* Linnaeus) and other Brachycera, mosquitoes (e.g., *Aedes* spp., *Anopheles* spp., *Culex* spp.), black flies (e.g., *Prosimulium* spp., *Simulium* spp.), biting midges, sand flies, sciarids, and other Nematocera; adults and immatures of the order Thysanoptera including onion thrips (*Thrips tabaci* Lindeman), flower thrips (*Frankliniella* spp.), and other foliar feeding thrips; insect pests of the order Hymenoptera including ants (e.g., red carpenter ant (*Camponotus ferrugineus* Fabricius), black carpenter ant (*Camponotus pennsylvanicus* De Geer), Pharaoh ant (*Monomorium pharaonis* Linnaeus), little fire ant (*Wasmannia auropunctata* Roger), fire ant (*Solenopsis geminata* Fabricius), red imported fire ant (*Solenopsis invicta* Buren), Argentine ant (*Iridomyrmex humilis* Mayr), crazy ant (*Paratrechina longicornis* Latreille), pavement ant (*Tetramorium caespitum* Linnaeus), cornfield ant (*Lasius alienus* Förster), odorous house ant (*Tapinoma sessile* Say), bees (including carpenter bees), hornets, yellow jackets, wasps, and sawflies (*Neodiprion* spp.; *Cephus* spp.); insect pests of the Family Formicidae including the Florida carpenter ant (*Camponotus floridanus* Buckley), white-footed ant (*Technomyrmex albipes* fr. Smith), big headed ants (*Pheidole* sp.) and ghost ant (*Tapinoma melanocephalum* Fabricius); insect pests of the order Isoptera including termites in the Termitidae (ex. *Macrotermes* sp.), Kalotermitidae (ex. *Cryptotermes* sp.), and Rhinotermitidae (ex. *Reticulitermes* sp., *Coptotermes* sp.) families the eastern subterranean termite (*Reticulitermes flavipes* Kollar), western subterranean termite (*Reticulitermes hesperus* Banks), Formosan subterranean termite (*Coptotermes formosanus* Shiraki), West Indian drywood termite (*Incisitermes immigrans* Snyder), powder post termite (*Cryptotermes brevis* Walker), drywood termite (*Incisitermes snyderi* Light), southeastern subterranean termite (*Reticulitermes virginicus* Banks), western drywood termite (*Incisitermes minor* Hagen), arboreal termites such as *Nasutitermes* sp. and other termites of economic importance; insect pests of the order Thysanura such as silverfish (*Lepisma saccharina* Linnaeus) and firebrat (*Thermobia domestica* Packard); insect pests of the order Mallophaga and including the head louse (*Pediculus humanus capitis* De Geer), body louse (*Pediculus humanus humanus* Linnaeus), chicken body louse (*Menacanthus stramineus* Nitszch), dog biting louse (*Trichodectes canis* De Geer), fluff louse (*Goniocotes gallinae* De Geer), sheep body louse (*Bovicola ovis* Schrank), short-nosed cattle louse (*Haematopinus eurysternus* Nitzsch), long-nosed cattle louse (*Linognathus vituli* Linnaeus) and other sucking and chewing parasitic lice that attack man and animals; insect pests of the order Siphonoptera including the oriental rat flea (*Xenopsylla cheopis* Rothschild), cat flea (*Ctenocephalides felis* Bouche), dog flea (*Ctenocephalides canis* Curtis), hen flea (*Ceratophyllus gallinae* Schrank), sticktight flea

(*Echidnophaga gallinacea* Westwood), human flea (*Pulex irritans* Linnaeus) and other fleas afflicting mammals and birds. Additional arthropod pests covered include: spiders in the order Araneae such as the brown recluse spider (*Loxosceles reclusa* Gertsch & Mulaik) and the black widow spider (*Latrodectus mactans* Fabricius), and centipedes in the order Scutigeromorpha such as the house centipede (*Scutigera coleoptrata* Linnaeus). Mixtures and compositions of the present invention also have activity on members of the Classes Nematoda, Cestoda, Trematoda, and Acanthocephala including economically important members of the orders Strongylida, Ascaridida, Oxyurida, Rhabditida, Spirurida, and Enoplida such as but not limited to economically important agricultural pests (i.e. root knot nematodes in the genus *Meloidogyne*, lesion nematodes in the genus *Pratylenchus*, stubby root nematodes in the genus *Trichodorus*, etc.) and animal and human health pests (i.e. all economically important flukes, tapeworms, and roundworms, such as *Strongylus vulgaris* in horses, *Toxocara canis* in dogs, *Haemonchus contortus* in sheep, *Dirofilaria immitis* Leidy in dogs, *Anoplocephala perfoliata* in horses, *Fasciola hepatica* Linnaeus in ruminants, etc.).

Of note is use of a mixture of this invention for controlling silverleaf whitefly (*Bemisia argentifolii*), wherein one embodiment comprises using a mixture wherein the component (b) is a (b1) compound, e.g., imidacloprid, thiacloprid or thiamethoxam; a (b2) compound, e.g., thiodicarb; a (b3) compound, e.g., deltamethrin; a (b4) compound, e.g., buprofezin, cyromazine, hexaflumuron or novaluron; a (b7) compound, e.g., spinosad; a (b8) compound, e.g., fipronil; a (b9) compound, e.g., methoprene; a (b12) compound, e.g., pyridaben; or a (b13) compound, e.g., cartap. Of further note is use of a mixture of this invention for controlling silverleaf whitefly (*Bemisia argentifolii*), wherein another embodiment comprises using a mixture wherein the component (b) is at least one invertebrate pest control agent (or salt thereof) from each of two different groups selected from (b1), (b2), (b3), (b4), (b5), (b6), (b7), (b8), (b9), (b10), (b11), (b12), (b13), (b14), (b15), (b16), (b17), (b18) and (b19).

Of note is use of a mixture of this invention for controlling western flower thrip (*Frankliniella occidentalis*), wherein one embodiment comprises using a mixture wherein the component (b) is a (b1) compound, e.g., imidacloprid; a (b4) compound, e.g., hexaflumuron; or a (b13) compound, e.g., cartap. Of further note is use of a mixture of this invention for controlling western flower thrip (*Frankliniella occidentalis*), wherein another embodiment comprises using a mixture wherein the component (b) is at least one invertebrate pest control agent (or salt thereof) from each of two different groups selected from (b1), (b2), (b3), (b4), (b5), (b6), (b7), (b8), (b9), (b10), (b11), (b12), (b13), (b14), (b15), (b16), (b17), (b18) and (b19).

Of note is use of a mixture of this invention for controlling potato leafhopper (*Empoasca fabae*), wherein one embodiment comprises using a mixture wherein the component (b) is a (b1) compound, e.g., dinotefuran, imidacloprid or nitenpyram; a (b2)

compound, e.g., methomyl or oxamyl; a (b3) compound, e.g., deltamethrin, esfenvalerate or lambda-cyhalothrin; a (b4) compound, e.g., hexaflumuron, lufenuron or novaluron; a (b5) compound, e.g., methoxyfenozide; a (b7) compound, e.g., abamectin or spinosad; a (b9) compound, e.g., methoprene; a (b11) compound, e.g., amitraz; a (b12) compound, e.g., hydramethylnon or chlorfenapyr; a (b15) compound, flonicamid; or a (b16) compound, pymetrozine. Of further note is use of a mixture of this invention for controlling potato leafhopper (*Empoasca fabae*), wherein another embodiment comprises using a mixture wherein component (b) is at least one invertebrate pest control agent (or salt thereof) from each of two different groups selected from (b1), (b2), (b3), (b4), (b5), (b6), (b7), (b8), (b9), (b10), (b11), (b12), (b13), (b14), (b15), (b16), (b17), (b18) and (b19).

Of note is use of a mixture of this invention for controlling corn plant hopper (*Peregrinus maidis*), wherein one embodiment comprises using a mixture wherein the component (b) is a (b1) compound, e.g., dinotefuran or thiacloprid; a (b2) compound, e.g., triazamate; a (b3) compound, e.g., indoxacarb; a (b9) compound, e.g., fenoxycarb; a (b14) compound,pyridalyl; a (b15) compound, flonicamid; a (b16) compound, pymetrozine; or a (b17) compound, dieldrin. Of further note is use of a mixture of this invention for controlling corn plant hopper (*Peregrinus maidis*), wherein another embodiment comprises using a mixture wherein the component (b) is at least one invertebrate pest control agent (or salt thereof) from each of two different groups selected from (b1), (b2), (b3), (b4), (b5), (b6), (b7), (b8), (b9), (b10), (b11), (b12), (b13), (b14), (b15), (b16), (b17), (b18) and (b19).

Of note is use of a mixture of this invention for controlling cotton melon aphid (*Aphis gossypii*), wherein one embodiment comprises using a mixture wherein the component (b) is a (b1) compound, e.g., imidacloprid, nitenpyram, thiacloprid or thiamethoxam; a (b2) compound, e.g., oxamyl; a (b3) compound, e.g., lambda-cyhalothrin; a (b4) compound, e.g., novaluron; a (b7) compound, e.g., abamectin; a (b8) compound, e.g., fipronil; a (b9) compound, e.g., fenoxycarb, methoprene or pyriproxyfen; a (b11) compound, e.g., amitraz; a (b12) compound, e.g., chlorfenapyr or pyridaben; a (b13) compound, e.g., cartap; a (b15) compound, flonicamid; a (b16) compound, pymetrozine; or a (b17) compound, dieldrin. Of further note is use of a mixture of this invention for controlling cotton melon aphid (*Aphis gossypii*), wherein another embodiment comprises using a mixture wherein the component (b) is at least one invertebrate pest control agent (or salt thereof) from each of two different groups selected from (b1), (b2), (b3), (b4), (b5), (b6), (b7), (b8), (b9), (b10), (b11), (b12), (b13), (b14), (b15), (b16), (b17), (b18) and (b19).

Of note is use of a mixture of this invention for controlling green peach aphid (*Myzus persicae*), wherein one embodiment comprises using a mixture wherein the component (b) is a (b1) compound, e.g., acetamiprid, dinotefuran or imidacloprid; a (b2) compound, e.g., oxamyl; a (b7) compound, e.g., spinosad; a (b9) compound, e.g., methoprene; a (b15) compound, flonicamid; a (b16) compound, pymetrozine; or a (b17) compound, dieldrin. Of

further note is use of a mixture of this invention for controlling green peach aphid (*Myzus persicae*), wherein another embodiment comprises using a mixture wherein the component (b) is at least one invertebrate pest control agent (or salt thereof) from each of two different groups selected from (b1), (b2), (b3), (b4), (b5), (b6), (b7), (b8), (b9), (b10), (b11), (b12), (b13), (b14), (b15), (b16), (b17), (b18) and (b19).

Of note is use of a mixture of this invention for controlling beet armyworm (*Spodoptera exigua*), wherein one embodiment comprises using a mixture wherein the component (b) is a (b1) compound, e.g., imidacloprid; a (b2) compound, e.g., methomyl or oxamyl; or a (b3) compound, e.g., indoxacarb. Of further note is use of a mixture of this invention for controlling beet armyworm (*Spodoptera exigua*), wherein another embodiment comprises using a mixture wherein the component (b) is at least one invertebrate pest control agent (or salt thereof) from each of two different groups selected from (b1), (b2), (b3), (b4), (b5), (b6), (b7), (b8), (b9), (b10), (b11), (b12), (b13), (b14), (b15), (b16), (b17), (b18) and (b19).

Of note is use of a mixture of this invention for controlling cabbage looper (*Trichoplusia ni*), wherein one embodiment comprises using a mixture wherein the component (b) is a (b1) compound, e.g., imidacloprid; a (b2) compound, e.g., methomyl or oxamyl; or a (b3) compound, e.g., indoxacarb. Of further note is use of a mixture of this invention for controlling cabbage looper (*Trichoplusia ni*), wherein another embodiment comprises using a mixture wherein the component (b) is at least one invertebrate pest control agent (or salt thereof) from each of two different groups selected from (b1), (b2), (b3), (b4), (b5), (b6), (b7), (b8), (b9), (b10), (b11), (b12), (b13), (b14), (b15), (b16), (b17), (b18) and (b19).

Of note is use of a mixture of this invention for controlling diamondback moth (*Plutella xylostella*), wherein one embodiment comprises using a mixture wherein the component (b) is a (b1) compound, e.g., imidacloprid; a (b2) compound, e.g., methomyl or oxamyl; a (b3) compound, e.g., indoxacarb; or a (b15) compound, flonicamid. Of further note is use of a mixture of this invention for controlling diamondback moth (*Plutella xylostella*), wherein another embodiment comprises using a mixture wherein the component (b) is at least one invertebrate pest control agent (or salt thereof) from each of two different groups selected from (b1), (b2), (b3), (b4), (b5), (b6), (b7), (b8), (b9), (b10), (b11), (b12), (b13), (b14), (b15), (b16), (b17), (b18) and (b19).

Invertebrate pests are controlled in agronomic and nonagronomic applications by applying a composition or mixture of this invention, in an effective amount, to the environment of the pests, including the agronomic and/or nonagronomic locus of infestation, to the area to be protected, or directly on the pests to be controlled. Agronomic applications include protecting a field crop from invertebrate pests typically by applying a composition or a mixture of the invention to the seed of the crop before the planting, to the foliage, stems,

flowers and/or fruit of crop plants, or to the soil or other growth medium before or after the crop is planted. Nonagronomic applications refer to invertebrate pest control in the areas other than fields of crop plants. Nonagronomic applications include control of invertebrate pests in stored grains, beans and other foodstuffs, and in textiles such as clothing and carpets. Nonagronomic applications also include invertebrate pest control in ornamental plants, forests, in yards, along road sides and railroad rights of way, and on turf such as lawns, golf courses and pastures. Nonagronomic applications also include invertebrate pest control in houses and other buildings which may be occupied by humans and/or companion, farm, ranch, zoo or other animals. Nonagronomic applications also include the control of pests such as termites that can damage wood or other structural materials used in buildings. Nonagronomic applications also include protecting human and animal health by controlling invertebrate pests that are parasitic or transmit infectious diseases. Such pests include, for example, chiggers, ticks, lice, mosquitoes, flies and fleas.

Therefore, the present invention further comprises a method for controlling an invertebrate pest in agronomic and/or nonagronomic applications, comprising contacting the invertebrate pest or its environment with a biologically effective amount of a mixture comprising the compound of Formula 1, an *N*-oxide or salt thereof, and at least one invertebrate pest control agent (or salt thereof) selected from the group consisting of (b1), (b2), (b3), (b4), (b5), (b6), (b7), (b8), (b9), (b10), (b11), (b12), (b13), (b14), (b15), (b16), (b17), (b18) and (b19). Examples of suitable compositions comprising an effective amount of the compound of Formula 1 and an effective amount of a component (b) include granular compositions wherein the component (b) is present on the same granule as the compound of Formula 1, an *N*-oxide or a salt thereof or on granules separate from those of the compound of Formula 1, an *N*-oxide or a salt thereof. Of note is an embodiment wherein component (b) is a (b1) compound, e.g. imidacloprid, a (b2) compound, e.g., methomyl or oxamyl, or a (b3) compound, e.g., indoxacarb or component (b) comprises at least one invertebrate pest control agent (or salt thereof) from each of two different groups selected from (b1), (b2), (b3), (b4), (b5), (b6), (b7), (b8), (b9), (b10), (b11), (b12), (b13), (b14), (b15), (b16), (b17), (b18) and (b19).

One embodiment of a method of contact is by spraying. Alternatively, a granular composition comprising a mixture or composition of the invention can be applied to the plant foliage or the soil. Mixtures and compositions of this invention are also effectively delivered through plant uptake by contacting the plant with a mixture or composition of this invention comprising the compound of Formula 1, an *N*-oxide or a salt thereof and an invertebrate pest control agent of component (b) applied as a soil drench of a liquid formulation, a granular formulation to the soil, a nursery box treatment or a dip of transplants. Of note is a composition of the present invention in the form of a soil drench liquid formulation. Also of note is a method for controlling an invertebrate pest comprising

contacting the soil environment of the invertebrate pest with a biologically effective amount of the mixture of the present invention. Of further note are such methods wherein the mixture is of Embodiment 1-4, 6, 7, 9, 10, 15-20, 22, 23, 25, 26, 28-33, 35, 36, 38-45 or 46.

Mixtures and compositions of this invention are also effective by topical application to the locus of infestation. Other methods of contact include application of a mixture or composition of the invention by direct and residual sprays, aerial sprays, gels, seed coatings, microencapsulations, systemic uptake, baits, eartags, boluses, foggers, fumigants, aerosols, dusts and many others. One embodiment of a method of contact is a dimensionally stable fertilizer granule, stick or tablet comprising a mixture or composition of the invention. The compositions and mixtures of this invention can also be impregnated into materials for fabricating invertebrate control devices (e.g., insect netting). Seed coatings can be applied to all types of seeds, including those from which plants genetically transformed to express specialized traits will germinate. Representative examples include those expressing proteins toxic to invertebrate pests, such as *Bacillus thuringiensis* toxin or those expressing herbicide resistance, such as "Roundup Ready" seed. A mixture or composition of this invention can be incorporated into a bait composition that is consumed by an invertebrate pest or used within a device such as a trap, bait station, and the like. Such a bait composition can be in the form of granules which comprise (a) active ingredients, namely the compound of Formula 1, an *N*-oxide, or salt thereof; (b) an invertebrate pest control agent or salt thereof selected from the group consisting of (b1), (b2), (b3), (b4), (b5), (b6), (b7), (b8), (b9), (b10), (b11), (b12), (b13), (b14), (b15), (b16), (b17), (b18) and (b19); (c) one or more food materials; optionally (d) an attractant, and optionally (e) one or more humectants. Of note are granules or bait compositions which comprise between about 0.001-5% active ingredients, about 40-99% food material and/or attractant; and optionally about 0.05-10% humectants, which are effective in controlling soil invertebrate pests at very low application rates, particularly at doses of active ingredient that are lethal by ingestion rather than by direct contact. Some food materials can function both as a food source and an attractant. Food materials include carbohydrates, proteins and lipids. Examples of food materials are vegetable flour, sugar, starches, animal fat, vegetable oil, yeast extracts and milk solids. Examples of attractants are odorants and flavorants, such as fruit or plant extracts, perfume, or other animal or plant component, pheromones or other agents known to attract a target invertebrate pest. Examples of humectants, i.e. moisture retaining agents, are glycols and other polyols, glycerine and sorbitol. Of note is a bait composition (and a method utilizing such a bait composition) used to control at least one invertebrate pest selected from the group consisting of ants, termites and cockroaches, including individually or in combinations. A device for controlling an invertebrate pest can comprise the present bait composition and a housing adapted to receive the bait composition, wherein the housing has at least one opening sized to permit the invertebrate pest to pass through the opening so the

invertebrate pest can gain access to the bait composition from a location outside the housing, and wherein the housing is further adapted to be placed in or near a locus of potential or known activity for the invertebrate pest.

The mixtures and compositions of this invention can be applied without other adjuvants, but most often application will be of a formulation comprising one or more active ingredients with suitable carriers, diluents, and surfactants and possibly in combination with a food depending on the contemplated end use. One method of application involves spraying a water dispersion or refined oil solution of the mixture or composition of the present invention. Combinations with spray oils, spray oil concentrations, spreader stickers, adjuvants, other solvents, and synergists such as piperonyl butoxide often enhance compound efficacy. For nonagronomic uses such sprays can be applied from spray containers such as a can, a bottle or other container, either by means of a pump or by releasing it from a pressurized container, e.g., a pressurized aerosol spray can. Such spray compositions can take various forms, for example, sprays, mists, foams, fumes or fog. Such spray compositions thus can further comprise propellants, foaming agents, etc. as the case may be. Of note is a spray composition comprising a mixture or composition of the present invention and a propellant. Representative propellants include, but are not limited to, methane, ethane, propane, butane, isobutane, butene, pentane, isopentane, neopentane, pentene, hydrofluorocarbons, chlorofluorocarbons, dimethyl ether, and mixtures of the foregoing. Of note is a spray composition (and a method utilizing such a spray composition dispensed from a spray container) used to control at least one invertebrate pest selected from the group consisting of mosquitoes, black flies, stable flies, deer flies, horse flies, wasps, yellow jackets, hornets, ticks, spiders, ants, gnats, and the like, including individually or in combinations.

The rate of application required for effective control (i.e. "biologically effective amount") will depend on such factors as the species of invertebrate to be controlled, the pest's life cycle, life stage, its size, location, time of year, host crop or animal, feeding behavior, mating behavior, ambient moisture, temperature, and the like. Under normal circumstances, application rates of about 0.01 to 2 kg of active ingredients per hectare are sufficient to control pests in agronomic ecosystems, but as little as 0.0001 kg/hectare may be sufficient or as much as 8 kg/hectare may be required. For nonagronomic applications, effective use rates will range from about 1.0 to 50 mg/square meter but as little as 0.1 mg/square meter may be sufficient or as much as 150 mg/square meter may be required. One skilled in the art can easily determine the biologically effective amount necessary for the desired level of invertebrate pest control.

Synergism has been described as "the cooperative action of two components (e.g., component (a) and component (b)) in a mixture, such that the total effect is greater or more prolonged than the sum of the effects of the two (or more) taken independently" (see

P. M. L. Tames, *Neth. J. Plant Pathology* **1964**, *70*, 73–80). Mixtures containing the compound of Formula 1 together with other invertebrate pest control agents are found to exhibit synergistic effects against certain important invertebrate pests.

The presence of a synergistic effect between two active ingredients is established with the aid of the Colby equation (see S. R. Colby, "Calculating Synergistic and Antagonistic Responses of Herbicide Combinations", *Weeds*, **1967**, *15*, 20–22):

$$p = A + B - \left[\frac{A \times B}{100} \right]$$

Using the method of Colby, the presence of a synergistic interaction between two active ingredients is established by first calculating the predicted activity, p, of the mixture based on activities of the two components applied alone. If p is lower than the experimentally established effect, synergism has occurred. If p is equal or higher than the experimentally established effect, the interaction between the two components is characterized to be only additive or antagonism. In the equation above, A is the observed result of one component applied alone at rate x. The B term is the observed result of the second component applied at rate y. The equation estimates p, the observed result of the mixture of A at rate x with B at rate y if their effects are strictly additive and no interaction has occurred. To use the Colby equation the active ingredients of the mixture are applied in the test separately as well as in combination.

BIOLOGICAL EXAMPLES OF THE INVENTION

The following tests demonstrate the control efficacy of mixtures or compositions of this invention on specific pests. The pest control protection afforded by the mixtures or compositions is not limited, however, to these species. The analysis of synergism or antagonism between the mixtures or compositions was determined using Colby's equation. The average % mortality data for the test compounds alone were inserted into the Colby's equation. If the observed (obs) average % mortality was higher than "p", the expected % mortality, the mixture or composition had synergistic effects. If the observed average % mortality was equal to or lower than the expected mortality, the mixture or composition either had no synergistic effect or an antagonistic effect. In these tests, Compound 1 (Cpd 1) is the compound of Formula 1.

TEST A

For evaluating control of silverleaf whitefly (*Bemisia argentifolii* Bellows and Perring) through contact and/or systemic means, each test unit consisted of a small open container with a 12- to 14-day-old cotton plant inside. This was pre-infested by placing test units into cages infested with adult whiteflies so that oviposition on the cotton leaves could occur. The adults were removed from the plants with an air-blast nozzle, and the test units were capped. The test units were then stored 2 to 3 days before spraying.

Test compounds were formulated using a solution containing 10% acetone, 90% water and 300 ppm X-77® Spreader Lo-Foam Formula non-ionic surfactant containing alkylarylpolyoxyethylene, free fatty acids, glycols and 2-propanol (Loveland Industries, Inc.) to provide the desired concentration in ppm. Formulated test solutions were then applied in 1 mL volumes through a SUJ2 atomizer nozzle with 1/8 JJ custom body (Spraying Systems Co.) positioned 1.27 cm (0.5 inches) above the top of each test unit.

The results for all experimental compositions in this test were replicated three times. After spraying of the formulated test composition, each test unit was allowed to dry for 1 hour and the cap removed. The test units were held for 13 days in a growth chamber at 28 °C and 50–70% relative humidity. Each test unit was then assessed for insect mortality using a binocular microscope; the results are listed in Tables 2A and 2B.

Table 2A

Silverleaf Whitefly				
Compound 1 (ppm)	Imidacloprid (ppm)	Ratio	% Mortality (observed)	% Mortality (calculated)
6	0	-	0	-
8	0	-	4	-
10	0	-	1	-
0	10	-	1	-
0	22	-	2	-
0	48	-	25	-
6	10	1:1.7	24	1
6	22	1:3.7	46	2
6	48	1:8.0	83	25
8	10	1:1.3	49	5
8	22	1:2.8	59	6
8	48	1:6	87	28
10	10	1:1	21	2
10	22	1:2.2	68	3
10	48	1:4.8	59	26

Table 2B

* indicates the observed % mortality is higher than the calculated % mortality by Colby equation.

Silverleaf Whitefly	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Compound 1	6	3	8	3	10	5
Methomyl	10	4	100	3	1000	6
Cpd 1 + Methomyl	6 + 10	8	8 + 10	0	10 + 10	0

Silverleaf Whitefly	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Methomyl	6 + 100	4	8 + 100	0	10 + 100	0
Cpd 1 + Methomyl	6 + 1000	5	8 + 1000	9	10 + 1000	6
Amitraz	500	5	1000	0	2000	0
Cpd 1 + Amitraz	6 + 500	0	8 + 500	0	10 + 500	1
Cpd 1 + Amitraz	6 + 1000	0	8 + 1000	0	10 + 1000	0
Cpd 1 + Amitraz	6 + 2000	0	8 + 2000	0	10 + 2000	0
Thiamethoxam	5	15	15	78	30	92
Cpd 1 + Thiamethoxam	6 + 5	43*	8 + 5	28*	10 + 5	72*
Cpd 1 + Thiamethoxam	6 + 15	93*	8 + 15	80*	10 + 15	60
Cpd 1 + Thiamethoxam	6 + 30	99*	8 + 30	96*	10 + 30	100*
Pyridaben	20	21	30	55	50	73
Cpd 1 + Pyridaben	6 + 20	4	8 + 20	4	10 + 20	18
Cpd 1 + Pyridaben	6 + 30	18	8 + 30	38	10 + 30	47
Cpd 1 + Pyridaben	6 + 50	100*	8 + 50	100*	10 + 50	100*
Flonicamid	0.1	2	0.2	2	0.5	2
Cpd 1 + Flonicamid	6 + 0.1	0	8 + 0.1	0	10 + 0.1	5
Cpd 1 + Flonicamid	6 + 0.2	0	8 + 0.2	0	10 + 0.2	0
Cpd 1 + Flonicamid	6 + 0.5	0	8 + 0.5	2	10 + 0.5	4
Dieldrin	10	0	100	0	1000	0
Cpd 1 + Dieldrin	6 + 10	1	8 + 10	0	10 + 10	0
Cpd 1 + Dieldrin	6 + 100	0	8 + 100	0	10 + 100	0
Cpd 1 + Dieldrin	6 + 1000	0	8 + 1000	0	10 + 1000	0
Spinosad	100	66	150	69	300	95
Cpd 1 + Spinosad	6 + 100	75*	8 + 100	88*	10 + 100	78*
Cpd 1 + Spinosad	6 + 150	96*	8 + 150	89*	10 + 150	96*
Cpd 1 + Spinosad	6 + 300	100*	8 + 300	100*	10 + 300	100*
Fipronil	50	1	100	0	1000	13
Cpd 1 + Fipronil	6 + 50	5	8 + 50	2	10 + 50	13
Cpd 1 + Fipronil	6 + 100	2	8 + 100	26*	10 + 100	19*
Cpd 1 + Fipronil	6 + 1000	16	8 + 1000	16	10 + 1000	23
Pyriproxyfen	10	100	15	100	20	100
Cpd 1 + Pyriproxyfen	6 + 10	77	8 + 10	85	10 + 10	100
Cpd 1 + Pyriproxyfen	6 + 15	98	8 + 15	100	10 + 15	100
Cpd 1 + Pyriproxyfen	6 + 20	99	8 + 20	90	10 + 20	100

Silverleaf Whitefly	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Pymetrozine	10	3	100	7	1000	52
Cpd 1 + Pymetrozine	6 + 10	0	8 + 10	0	10 + 10	0
Cpd 1 + Pymetrozine	6 + 100	3	8 + 100	0	10 + 100	0
Cpd 1 + Pymetrozine	6 + 1000	0	8 + 1000	0	10 + 1000	1
Buprofezin	300	75	500	65	1000	96
Cpd 1 + Buprofezin	6 + 300	57	8 + 300	99*	10 + 300	98*
Cpd 1 + Buprofezin	6 + 500	93*	8 + 500	97*	10 + 500	96*
Cpd 1 + Buprofezin	6 + 1000	99*	8 + 1000	100*	10 + 1000	98*
Chlorfenapyr	10	6	100	14	1000	18
Cpd 1 + Chlorfenapyr	6 + 10	8	8 + 10	10*	10 + 10	1
Cpd 1 + Chlorfenapyr	6 + 100	2	8 + 100	1	10 + 100	3
Cpd 1 + Chlorfenapyr	6 + 1000	35*	8 + 1000	49*	10 + 1000	13
Chlorpyrifos	500	0	1000	0	2000	0
Cpd 1 + Chlorpyrifos	6 + 500	4	8 + 500	1	10 + 500	8
Cpd 1 + Chlorpyrifos	6 + 1000	1	8 + 1000	1	10 + 1000	7
Cpd 1 + Chlorpyrifos	6 + 2000	7	8 + 2000	2	10 + 2000	2
Cyromazine	10	1	100	2	1000	2
Cpd 1 + Cyromazine	6 + 10	41*	8 + 10	84*	10 + 10	79*
Cpd 1 + Cyromazine	6 + 100	63*	8 + 100	75*	10 + 100	88*
Cpd 1 + Cyromazine	6 + 1000	51*	8 + 1000	66*	10 + 1000	91*
Fenoxycarb	2	0	10	0	20	21
Cpd 1 + Fenoxycarb	6 + 2	0	8 + 2	2	10 + 2	0
Cpd 1 + Fenoxycarb	6 + 10	4	8 + 10	11	10 + 10	14
Cpd 1 + Fenoxycarb	6 + 20	29*	8 + 20	35*	10 + 20	33*
Methoprene	500	11	1000	22	2000	60
Cpd 1 + Methoprene	6 + 500	3	8 + 500	9	10 + 500	17*
Cpd 1 + Methoprene	6 + 1000	52*	8 + 1000	59*	10 + 1000	90*
Cpd 1 + Methoprene	6 + 2000	63*	8 + 2000	78*	10 + 2000	97*
Indoxacarb	1	0	3	0	10	0
Cpd 1 + Indoxacarb	6 + 1	0	8 + 1	0	10 + 1	0
Cpd 1 + Indoxacarb	6 + 3	0	8 + 3	0	10 + 3	0
Cpd 1 + Indoxacarb	6 + 10	0	8 + 10	0	10 + 10	0
Thiodicarb	100	1	1000	0	3000	6
Cpd 1 + Thiodicarb	6 + 100	7	8 + 100	8	10 + 100	8

Silverleaf Whitefly	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Thiodicarb	6 + 1000	5	8 + 1000	7	10 + 1000	17*
Cpd 1 + Thiodicarb	6 + 3000	39*	8 + 3000	18	10 + 3000	11
Tebufenozide	100	2	1000	6	3000	7
Cpd 1 + Tebufenozide	6 + 100	26*	8 + 100	10	10 + 100	15*
Cpd 1 + Tebufenozide	6 + 1000	5	8 + 1000	1	10 + 1000	8
Cpd 1 + Tebufenozide	6 + 3000	3	8 + 3000	4	10 + 3000	20*
Deltamethrin	30	2	40	0	50	1
Cpd 1 + Deltamethrin	6 + 30	6	8 + 30	4	10 + 30	13
Cpd 1 + Deltamethrin	6 + 40	3	8 + 40	21*	10 + 40	17*
Cpd 1 + Deltamethrin	6 + 50	3	8 + 50	14*	10 + 50	16*
Oxamyl	0.1	2	0.3	0	1	1
Cpd 1 + Oxamyl	6 + 0.1	1	8 + 0.1	2	10 + 0.1	4
Cpd 1 + Oxamyl	6 + 0.3	1	8 + 0.3	0	10 + 0.3	10*
Cpd 1 + Oxamyl	6 + 1	2	8 + 1	11*	10 + 1	7
Hexaflumuron	10	1	60	0	360	0
Cpd 1 + Hexaflumuron	6 + 10	37*	8 + 10	41*	10 + 10	90*
Cpd 1 + Hexaflumuron	6 + 60	51*	8 + 60	71*	10 + 60	75*
Cpd 1 + Hexaflumuron	6 + 360	78*	8 + 360	75*	10 + 360	75*
Acetamiprid	1	3	5	45	20	83
Cpd 1 + Acetamiprid	6 + 1	13*	8 + 1	1	10 + 1	4
Cpd 1 + Acetamiprid	6 + 5	39	8 + 5	50*	10 + 5	45
Cpd 1 + Acetamiprid	6 + 20	91*	8 + 20	93*	10 + 20	87*
Cartap	0.1	0	0.2	0	0.5	0
Cpd 1 + Cartap	6 + 0.1	1	8 + 0.1	14*	10 + 0.1	11*
Cpd 1 + Cartap	6 + 0.2	0	8 + 0.2	2	10 + 0.2	16*
Cpd 1 + Cartap	6 + 0.5	16*	8 + 0.5	2	10 + 0.5	25*
Esfenvalerate	50	1	100	0	200	0
Cpd 1 + Esfenvalerate	6 + 50	5	8 + 50	1	10 + 50	4
Cpd 1 + Esfenvalerate	6 + 100	3	8 + 100	6	10 + 100	2
Cpd 1 + Esfenvalerate	6 + 200	2	8 + 200	12*	10 + 200	0
Thiacloprid	15	40	25	83	35	61
Cpd 1 + Thiacloprid	6 + 15	81*	8 + 15	66*	10 + 15	97*
Cpd 1 + Thiacloprid	6 + 25	89*	8 + 25	75	10 + 25	93*
Cpd 1 + Thiacloprid	6 + 35	99*	8 + 35	100*	10 + 35	99*

Silverleaf Whitefly	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Lambda-cyhalothrin	10	0	50	1	250	100
Cpd 1 + Lambda-cyhalothrin	6 + 10	0	8 + 10	2	10 + 10	11*
Cpd 1 + Lambda-cyhalothrin	6 + 50	0	8 + 50	23*	10 + 50	10*
Cpd 1 + Lambda-cyhalothrin	6 + 250	6	8 + 250	14	10 + 250	89
Hydramethylnon	10	2	100	1	1000	0
Cpd 1 + Hydramethylnon	6 + 10	0	8 + 10	5	10 + 10	0
Cpd 1 + Hydramethylnon	6 + 100	0	8 + 100	1	10 + 100	3
Cpd 1 + Hydramethylnon	6 + 1000	0	8 + 1000	0	10 + 1000	2
Methoxyfenozide	2	1	10	2	50	1
Cpd 1 + Methoxyfenozide	6 + 2	1	8 + 2	0	10 + 2	2
Cpd 1 + Methoxyfenozide	6 + 10	0	8 + 10	0	10 + 10	4
Cpd 1 + Methoxyfenozide	6 + 50	6	8 + 50	3	10 + 50	4
Nitenpyram	20	53	30	84	40	85
Cpd 1 + Nitenpyram	6 + 20	59*	8 + 20	61*	10 + 20	47
Cpd 1 + Nitenpyram	6 + 30	56	8 + 30	79	10 + 30	55
Cpd 1 + Nitenpyram	6 + 40	64	8 + 40	99*	10 + 40	91*
Pyridalyl	10	0	25	0	100	0
Cpd 1 + Pyridalyl	6 + 10	0	8 + 10	0	10 + 10	0
Cpd 1 + Pyridalyl	6 + 25	0	8 + 25	0	10 + 25	0
Cpd 1 + Pyridalyl	6 + 100	1	8 + 100	0	10 + 100	1
Dinotefuran	10	74	25	97	100	100
Cpd 1 + Dinotefuran	6 + 10	4	8 + 10	3	10 + 10	19
Cpd 1 + Dinotefuran	6 + 25	72	8 + 25	74	10 + 25	88
Cpd 1 + Dinotefuran	6 + 100	100	8 + 100	99	10 + 100	98
Novaluron	2	2	10	0	250	28
Cpd 1 + Novaluron	6 + 2	5	8 + 2	8*	10 + 2	3
Cpd 1 + Novaluron	6 + 10	25*	8 + 10	1	10 + 10	11*
Cpd 1 + Novaluron	6 + 250	72*	8 + 250	67*	10 + 250	41*

TEST B

For evaluating control of the western flower thrip (*Frankliniella occidentalis* Pergande) through contact and/or systemic means, each test unit consisted of a small open container with a 5- to 7-day-old bean (var. Soleil) plant inside.

Test solutions were formulated and sprayed with 3 replications as described for Test A. After spraying, the test units were allowed to dry for 1 hour, 22 to 27 adult thrips were

added to each unit and then a black, screened cap was placed on top. The test units were held for 7 days at 25 °C and 45-55% relative humidity. Each test unit was then visually assessed for insect mortality; the results are listed in Tables 3A and 3B.

Table 3A

Western Flower Thrips				
Compound 1 (ppm)	Imidacloprid (ppm)	Ratio	% Mortality (observed)	% Mortality (calculated)
8	0	-	3	-
25	0	-	17	-
81	0	-	30	-
0	11	-	20	-
0	77	-	37	-
0	561	-	90	-
8	11	1:1.4	23	22
8	77	1:9.6	60	39
8	561	1:70	90	90
25	11	2.3:1	17	34
25	77	1:3.1	63	48
25	561	1:22.4	90	92
81	11	7.4:1	37	44
81	77	1.1:1	70	56
81	561	1:6.9	93	93

Table 3B

* indicates the observed % mortality is higher than the calculated % mortality by Colby equation.

Western Flower Thrip	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Compound 1	10	44	50	49	100	46
Methomyl	30	60	100	60	300	100
Cpd 1 + Methomyl	10 + 30	80*	50 + 30	60	100 + 30	60
Cpd 1 + Methomyl	10 + 100	80*	50 + 100	80	100 + 100	80*
Cpd 1 + Methomyl	10 + 300	100	50 + 300	90	100 + 300	90
Amitraz	10	40	100	30	1000	20
Cpd 1 + Amitraz	10 + 10	70*	50 + 10	40	100 + 10	60
Cpd 1 + Amitraz	10 + 100	60	50 + 100	70*	100 + 100	60
Cpd 1 + Amitraz	10 + 1000	50	50 + 1000	30	100 + 1000	60*
Thiamethoxam	5	20	50	80	250	90

Western Flower Thrip	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Thiamethoxam	10 + 5	20	50 + 5	30	100 + 5	50
Cpd 1 + Thiamethoxam	10 + 70	70	50 + 70	40	100 + 70	60
Cpd 1 + Thiamethoxam	10 + 250	90	50 + 250	90	100 + 250	90
Pyridaben	10	30	80	50	200	60
Cpd 1 + Pyridaben	10 + 10	50	50 + 10	20	100 + 10	30
Cpd 1 + Pyridaben	10 + 80	50	50 + 80	40	100 + 80	20
Cpd 1 + Pyridaben	10 + 200	80*	50 + 200	60	100 + 200	70
Flonicamid	10	20	100	80	1000	70
Cpd 1 + Flonicamid	10 + 10	40	50 + 10	60	100 + 10	40
Cpd 1 + Flonicamid	10 + 100	60	50 + 100	70	100 + 100	50
Cpd 1 + Flonicamid	10 + 1000	70	50 + 1000	70	100 + 1000	80
Dieldrin	10	10	100	20	1000	30
Cpd 1 + Dieldrin	10 + 10	20	50 + 10	20	100 + 10	20
Cpd 1 + Dieldrin	10 + 100	10	50 + 100	40	100 + 100	30
Cpd 1 + Dieldrin	10 + 1000	20	50 + 1000	30	100 + 1000	30
Spinosad	0.1	20	0.5	60	3	90
Cpd 1 + Spinosad	10 + 0.1	30	50 + 0.1	10	100 + 0.1	10
Cpd 1 + Spinosad	10 + 0.5	30	50 +0.5	50	100 + 0.5	50
Cpd 1 + Spinosad	10 + 3	90	50 + 3	70	100 + 3	60
Fipronil	0.5	100	2	100	10	100
Cpd 1 + Fipronil	10 + 0.5	100	50 +0.5	100	100 + 0.5	100
Cpd 1 + Fipronil	10 + 2	100	50 + 2	100	100 + 2	100
Cpd 1 + Fipronil	10 + 10	100	50 + 10	100	100 + 10	100
Pyriproxyfen	10	100	100	100	1000	100
Cpd 1 + Pyriproxyfen	10 + 10	100	50 + 10	100	100 + 10	100
Cpd 1 + Pyriproxyfen	10 + 100	100	50 + 100	100	100 + 100	100
Cpd 1 + Pyriproxyfen	10 + 1000	100	50 + 1000	100	100 + 1000	100
Pymetrozine	10	100	100	100	1000	100
Cpd 1 + Pymetrozine	10 + 10	100	50 + 10	100	100 + 10	100
Cpd 1 + Pymetrozine	10 + 100	100	50 + 100	100	100 + 100	100
Cpd 1 + Pymetrozine	10 + 1000	100	50 + 1000	100	100 + 1000	100
Buprofezin	10	20	100	20	1000	30
Cpd 1 + Buprofezin	10 + 10	20	50 + 10	10	100 + 10	30
Cpd 1 + Buprofezin	10 + 100	0	50 + 100	10	100 + 100	20

Western Flower Thrip	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Buprofezin	10 + 1000	20	50 + 1000	20	100 + 1000	30
Chlorfenapyr	5	40	20	70	150	90
Cpd 1 + Chlorfenapyr	10 + 5	20	50 + 5	30	100 + 5	40
Cpd 1 + Chlorfenapyr	10 + 20	40	50 + 20	30	100 + 20	40
Cpd 1 + Chlorfenapyr	10 + 150	90	50 + 150	90	100 + 150	90
Chlorpyrifos	10	20	100	10	1000	10
Cpd 1 + Chlorpyrifos	10 + 10	20	50 + 10	40	100 + 10	10
Cpd 1 + Chlorpyrifos	10 + 100	20	50 + 100	10	100 + 100	10
Cpd 1 + Chlorpyrifos	10 + 1000	30	50 + 1000	10	100 + 1000	20
Cyromazine	200	70	500	80	1000	70
Cpd 1 + Cyromazine	10 + 200	20	50 + 200	70	100 + 200	80
Cpd 1 + Cyromazine	10 + 500	80	50 + 500	40	100 + 500	40
Cpd 1 + Cyromazine	10 + 1000	50	50 + 1000	70	100 + 1000	40
Fenoxycarb	10	40	100	70	1000	60
Cpd 1 + Fenoxycarb	10 + 10	20	50 + 10	60	100 + 10	70*
Cpd 1 + Fenoxycarb	10 + 100	60	50 + 100	70	100 + 100	70
Cpd 1 + Fenoxycarb	10 + 1000	20	50 + 1000	40	100 + 1000	80*
Methoprene	10	80	100	60	1000	70
Cpd 1 + Methoprene	10 + 10	50	50 + 10	50	100 + 10	70
Cpd 1 + Methoprene	10 + 100	40	50 + 100	50	100 + 100	80*
Cpd 1 + Methoprene	10 + 1000	60	50 + 1000	70	100 + 1000	40
Indoxacarb	1	50	500	50	3000	50
Cpd 1 + Indoxacarb	10 + 1	60	50 + 1	60	100 + 1	60
Cpd 1 + Indoxacarb	10 + 500	50	50 + 500	40	100 + 500	60
Cpd 1 + Indoxacarb	10 + 3000	50	50 + 3000	60	100 + 3000	80*
Triazamate	10	70	1000	80	3000	90
Cpd 1 + Triazamate	10 + 10	60	50 + 10	70	100 + 10	90*
Cpd 1 + Triazamate	10 + 1000	70	50 + 1000	60	100 + 1000	80
Cpd 1 + Triazamate	10 + 3000	70	50 + 3000	80	100 + 3000	80
Thiodicarb	20	60	200	80	2000	1000
Cpd 1 + Thiodicarb	10 + 20	60	50 + 20	50	100 + 20	40
Cpd 1 + Thiodicarb	10 + 200	80	50 + 200	60	100 + 200	70
Cpd 1 + Thiodicarb	10 + 2000	90	50 + 2000	100	100 + 2000	90
Tebufenozide	100	70	1000	60	3000	60

Western Flower Thrip	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Tebufenozide	10 + 100	50	50 + 100	70	100 + 100	90*
Cpd 1 + Tebufenozide	10 + 1000	80	50 + 1000	70	100 + 1000	50
Cpd 1 + Tebufenozide	10 + 3000	70	50 + 3000	90*	100 + 3000	60
Deltamethrin	10	70	1000	70	3000	50
Cpd 1 + Deltamethrin	10 + 10	50	50 + 10	70	100 + 10	70
Cpd 1 + Deltamethrin	10 + 1000	70	50 + 1000	70	100 + 1000	70
Cpd 1 + Deltamethrin	10 + 3000	70	50 + 3000	80	100 + 3000	70
Oxamyl	1	30	50	40	500	100
Cpd 1 + Oxamyl	10 + 1	20	50 + 1	40	100 + 1	70*
Cpd 1 + Oxamyl	10 + 50	30	50 + 50	60	100 + 50	60
Cpd 1 + Oxamyl	10 + 500	100	50 + 500	100	100 + 500	100
Acetamiprid	1	70	100	90	3000	100
Cpd 1 + Acetamiprid	10 + 1	70	50 + 1	60	100 + 1	60
Cpd 1 + Acetamiprid	10 + 100	80	50 + 100	80	100 + 100	80
Cpd 1 + Acetamiprid	10 + 3000	100	50 + 3000	100	100 + 3000	100
Cartap	1	40	1000	100	3000	100
Cpd 1 + Cartap	10 + 1	100*	50 + 1	100*	100 + 1	100*
Cpd 1 + Cartap	10 + 1000	100	50 + 1000	100	100 + 1000	100
Cpd 1 + Cartap	10 + 3000	100	50 + 3000	100	100 + 3000	100
Esfenvalerate	10	20	20	40	30	30
Cpd 1 + Esfenvalerate	10 + 10	40	50 + 10	60	100 + 10	20
Cpd 1 + Esfenvalerate	10 + 20	50	50 + 20	50	100 + 20	40
Cpd 1 + Esfenvalerate	10 + 30	40	50 + 30	50	100 + 30	10
Thiacloprid	1	20	100	30	3000	40
Cpd 1 + Thiacloprid	10 + 1	30	50 + 1	30	100 + 1	30
Cpd 1 + Thiacloprid	10 + 100	30	50 + 100	30	100 + 100	60
Cpd 1 + Thiacloprid	10 + 3000	60	50 + 3000	50	100 + 3000	70
Lambda-cyhalothrin	10	40	50	40	250	40
Cpd 1 + Lambda-cyhalothrin	10 + 10	40	50 + 10	40	100 + 10	40
Cpd 1 + Lambda-cyhalothrin	10 + 50	40	50 + 50	50	100 + 50	50
Cpd 1 + Lambda-cyhalothrin	10 + 250	30	50 + 250	40	100 + 250	60
Hydramethylnon	10	60	500	50	1000	40
Cpd 1 + Hydramethylnon	10 + 10	40	50 + 10	60	100 + 10	50
Cpd 1 + Hydramethylnon	10 + 500	40	50 + 500	60	100 + 500	30

Western Flower Thrip	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Hydramethylnon	10 + 1000	40	50 + 1000	30	100 + 1000	40
Clothianidin	100	90	500	100	1000	100
Cpd 1 + Clothianidin	10 + 100	60	50 + 100	90	100 + 100	70
Cpd 1 + Clothianidin	10 + 500	80	50 + 500	80	100 + 500	90
Cpd 1 + Clothianidin	10 + 1000	100	50 + 1000	100	100 + 1000	100
Lufenuron	10	90	100	80	500	80
Cpd 1 + Lufenuron	10 + 10	90	50 + 10	100*	100 + 10	90
Cpd 1 + Lufenuron	10 + 100	90	50 + 100	90	100 + 100	90
Cpd 1 + Lufenuron	10 + 500	90	50 + 500	100*	100 + 500	90
Abamectin	1	100	10	100	100	100
Cpd 1 + Abamectin	10 + 1	100	50 + 1	100	100 + 1	100
Cpd 1 + Abamectin	10 + 10	100	50 + 10	100	100 + 10	100
Cpd 1 + Abamectin	10 + 100	100	50 + 100	100	100 + 100	100
Methoxyfenozide	10	60	100	60	500	60
Cpd 1 + Methoxyfenozide	10 + 10	50	50 + 10	60	100 + 10	50
Cpd 1 + Methoxyfenozide	10 + 50	40	50 + 50	50	100 + 50	40
Cpd 1 + Methoxyfenozide	10 + 500	60	50 + 500	60	100 + 500	70
Nitenpyram	5	20	50	50	500	80
Cpd 1 + Nitenpyram	10 + 5	30	50 + 5	30	100 + 5	40
Cpd 1 + Nitenpyram	10 + 50	50	50 + 50	50	100 + 50	40
Cpd 1 + Nitenpyram	10 + 500	90	50 + 500	80	100 + 500	90
Pyridalyl	5	30	50	60	500	100
Cpd 1 + Pyridalyl	10 + 5	50	50 + 5	50	100 + 5	30
Cpd 1 + Pyridalyl	10 + 50	60	50 + 50	50	100 + 50	50
Cpd 1 + Pyridalyl	10 + 500	90	50 + 500	100	100 + 500	90
Dinotefuran	0.5	50	20	60	100	70
Cpd 1 + Dinotefuran	10 + 0.5	40	50 +0.5	70	100 + 0.5	80*
Cpd 1 + Dinotefuran	10 + 20	40	50 + 20	80	100 + 20	80*
Cpd 1 + Dinotefuran	10 + 100	60	50 + 100	80	100 + 100	80
Novaluron	1	50	100	50	1000	80
Cpd 1 + Novaluron	10 + 1	40	50 + 1	70	100 + 1	50
Cpd 1 + Novaluron	10 + 100	60	50 + 100	80*	100 + 100	80*
Cpd 1 + Novaluron	10 + 1000	60	50 + 1000	50	100 + 1000	70

TEST C

For evaluating control of potato leafhopper (*Empoasca fabae* Harris) through contact and/or systemic means, each test unit consisted of a small open container with a 5- to 6-day-old Longio bean plant (primary leaves emerged) inside. White sand was added to the top of the soil, and one of the primary leaves was excised prior to application. Test compounds were formulated and sprayed with 3 replications as described for Test A. After spraying, the test units were allowed to dry for 1 hour before they were infested with 5 potato leafhoppers (18- to 21-day-old adults). A black, screened cap was placed on the top of each container. The test units were held for 6 days in a growth chamber at 19–21 °C and 50–70% relative humidity. Each test unit was then visually assessed for insect mortality; the results are listed in Tables 4A and 4B.

Table 4A

Potato Leafhopper				
Compound 1 (ppm)	Imidacloprid (ppm)	Ratio	% Mortality (observed)	% Mortality (calculated)
0.4	0	-	0	-
1.4	0	-	0	-
4.6	0	-	0	-
0	0.2	-	20	-
0	0.4	-	0	-
0	1	-	20	-
0.4	0.2	2:1	7	20
0.4	0.4	1:1	0	0
0.4	1	1:2.5	60	20
1.4	0.2	7:1	27	20
1.4	0.4	3.5:1	27	0
1.4	1	1.4:1	40	20
4.6	0.2	23:1	13	20
4.6	0.4	11.5:1	33	0
4.6	1	4.6:1	73	20

Table 4B

* indicates the observed % mortality is higher than the calculated % mortality by Colby equation.

Potato Leaf Hopper	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Compound 1	4	23	14	37	50	54
Methomyl	1	0	2	53	5	100
Cpd 1 + Methomyl	4 + 1	53*	14 + 1	40	50 + 1	53

Potato Leaf Hopper	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Methomyl	4 + 2	67*	14 + 2	93*	50 + 2	87*
Cpd 1 + Methomyl	4 + 5	100	14 + 5	100	50 + 5	93
Amitraz	10	0	100	7	1000	13
Cpd 1 + Amitraz	4 + 10	0	14 + 10	40	50 + 10	40
Cpd 1 + Amitraz	4 + 100	7	14 + 100	93*	50 + 100	80*
Cpd 1 + Amitraz	4 + 1000	53*	14 + 1000	87*	50 + 1000	93*
Thiamethoxam	0.1	80	0.2	100	0.4	100
Cpd 1 + Thiamethoxam	4 + 0.1	60	14 + 0.1	67	50 + 0.1	67
Cpd 1 + Thiamethoxam	4 + 0.2	73	14 + 0.2	73	50 + 0.2	60
Cpd 1 + Thiamethoxam	4 + 0.4	93	14 + 0.4	100	50 + 0.4	100
Pyridaben	1	0	2.5	13	10	100
Cpd 1 + Pyridaben	4 + 1	7	14 + 1	40	50 + 1	33
Cpd 1 + Pyridaben	4 + 2.5	20	14 + 2.5	33	50 + 2.5	47
Cpd 1 + Pyridaben	4 + 10	47	14 + 10	33	50 + 10	100
Flonicamid	100	100	400	100	1000	40
Cpd 1 + Flonicamid	4 + 100	100	14 + 100	100	50 + 100	100
Cpd 1 + Flonicamid	4 + 400	100	14 + 400	93	50 + 400	100
Cpd 1 + Flonicamid	4 + 1000	100	14 + 1000	100	50 + 1000	100
Dieldrin	2.5	27	5	100	10	100
Cpd 1 + Dieldrin	4 + 2.5	33	14 + 2.5	93*	50 + 2.5	33
Cpd 1 + Dieldrin	4 + 5	67	14 + 5	100	50 + 5	100
Cpd 1 + Dieldrin	4 + 10	100	14 + 10	100	50 + 10	73
Spinosad	110	47	30	73	100	80
Cpd 1 + Spinosad	4 + 10	87*	14 + 10	73*	50 + 10	100*
Cpd 1 + Spinosad	4 + 30	100*	14 + 30	100*	50 + 30	100*
Cpd 1 + Spinosad	4 + 100	100*	14 + 100	100*	50 + 100	100*
Fipronil	0.5	7	1	20	1.5	27
Cpd 1 + Fipronil	4 + 0.5	20	14 + 0.5	40	50 + 0.5	60
Cpd 1 + Fipronil	4 + 1	40	14 + 1	53	50 + 1	93*
Cpd 1 + Fipronil	4 + 1.5	53*	14 + 1.5	33	50 + 1.5	73
Pyriproxyfen	10	13	100	0	1000	7
Cpd 1 + Pyriproxyfen	4 + 10	13	14 + 10	53*	50 + 10	53
Cpd 1 + Pyriproxyfen	4 + 100	33*	14 + 100	33	50 + 100	53
Cpd 1 + Pyriproxyfen	4 + 1000	33*	14 + 1000	53	50 + 1000	40

Potato Leaf Hopper	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Pymetrozine	2	0	15	13	200	60
Cpd 1 + Pymetrozine	4 + 2	20	14 + 2	60*	50 + 2	73*
Cpd 1 + Pymetrozine	4 + 15	53*	14 + 15	60*	50 + 15	73*
Cpd 1 + Pymetrozine	4 + 200	53	14 + 200	87*	50 + 200	73
Buprofezin	10	20	100	20	1000	0
Cpd 1 + Buprofezin	4 + 10	0	14 + 10	13	50 + 10	13
Cpd 1 + Buprofezin	4 + 100	20	14 + 100	0	50 + 100	0
Cpd 1 + Buprofezin	4 + 1000	13	14 + 1000	0	50 + 1000	7
Chlorfenapyr	1	73	5	100	20	100
Cpd 1 + Chlorfenapyr	4 + 1	87*	14 + 1	80	50 + 1	100*
Cpd 1 + Chlorfenapyr	4 + 5	100	14 + 5	100	50 + 5	100
Cpd 1 + Chlorfenapyr	4 + 20	87	14 + 20	100	50 + 20	100
Chlorpyrifos	10	13	100	0	1000	7
Cpd 1 + Chlorpyrifos	4 + 10	7	14 + 10	7	50 + 10	13
Cpd 1 + Chlorpyrifos	4 + 100	0	14 + 100	0	50 + 100	20
Cpd 1 + Chlorpyrifos	4 + 1000	0	14 + 1000	13	50 + 1000	20
Cyromazine	10	7	100	0	1000	0
Cpd 1 + Cyromazine	4 + 10	7	14 + 10	7	50 + 10	60*
Cpd 1 + Cyromazine	4 + 100	0	14 + 100	27	50 + 100	100*
Cpd 1 + Cyromazine	4 + 1000	13	14 + 1000	27	50 + 1000	33
Fenoxycarb	10	0	100	20	1000	0
Cpd 1 + Fenoxycarb	4 + 10	7	14 + 10	13	50 + 10	40
Cpd 1 + Fenoxycarb	4 + 100	0	14 + 100	13	50 + 100	20
Cpd 1 + Fenoxycarb	4 + 1000	13	14 + 1000	27	50 + 1000	13
Methoprene	10	0	100	0	1000	0
Cpd 1 + Methoprene	4 + 10	20	14 + 10	100*	50 + 10	93*
Cpd 1 + Methoprene	4 + 100	13	14 + 100	73*	50 + 100	93*
Cpd 1 + Methoprene	4 + 1000	87*	14 + 1000	80*	50 + 1000	100*
Indoxacarb	0.5	33	1	20	2	27
Cpd 1 + Indoxacarb	4 + 0.5	7	14 + 0.5	20	50 + 0.5	67
Cpd 1 + Indoxacarb	4 + 1	0	14 + 1	47	50 + 1	33
Cpd 1 + Indoxacarb	4 + 2	0	14 + 2	27	50 + 2	87*
Triazamate	0.5	13	1	0	2	7
Cpd 1 + Triazamate	4 + 0.5	13	14 + 0.5	33	50 + 0.5	80*

Potato Leaf Hopper	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Triazamate	4 + 1	13	14 + 1	33	50 + 1	20
Cpd 1 + Triazamate	4 + 2	0	14 + 2	80*	50 + 2	7
Thiodicarb	0.08	0	0.16	20	0.4	20
Cpd 1 + Thiodicarb	4 + 0.08	7	14 + 0.08	47*	50 + 0.08	27
Cpd 1 + Thiodicarb	4 + 0.16	13	14 + 0.16	13	50 + 0.16	60
Cpd 1 + Thiodicarb	4 + 0.4	20	14 + 0.4	0	50 + 0.4	93*
Tebufenozide	3	40	4	27	5	20
Cpd 1 + Tebufenozide	4 + 3	27	14 + 3	27	50 + 3	93*
Cpd 1 + Tebufenozide	4 + 4	40	14 + 4	67*	50 + 4	47
Cpd 1 + Tebufenozide	4 + 5	20	14 + 5	100*	50 + 5	47
Deltamethrin	0.1	7	0.2	7	1	60
Cpd 1 + Deltamethrin	4 + 0.1	13	14 + 0.1	53*	50 + 0.1	73*
Cpd 1 + Deltamethrin	4 + 0.2	40	14 + 0.2	33	50 + 0.2	100*
Cpd 1 + Deltamethrin	4 + 1	60	14 + 1	100*	50 + 1	100*
Oxamyl	0.1	20	2	20	100	100
Cpd 1 + Oxamyl	4 + 0.1	7	14 + 0.1	73*	50 + 0.1	87*
Cpd 1 + Oxamyl	4 + 2	7	14 + 2	33	50 + 2	60
Cpd 1 + Oxamyl	4 + 100	93	14 + 100	100	50 + 100	100
Hexaflumuron	100	13	1000	13	3000	27
Cpd 1 + Hexaflumuron	4 + 100	7	14 + 100	33	50 + 100	80*
Cpd 1 + Hexaflumuron	4 + 1000	13	14 + 1000	80*	50 + 1000	87*
Cpd 1 + Hexaflumuron	4 + 3000	33	14 + 3000	53	50 + 3000	80*
Acetamiprid	1	27	4	60	12	87
Cpd 1 + Acetamiprid	4 + 1	7	14 + 1	20	50 + 1	53
Cpd 1 + Acetamiprid	4 + 4	60	14 + 4	60	50 + 4	60
Cpd 1 + Acetamiprid	4 + 12	87	14 + 12	100*	50 + 12	93
Cartap	0.1	20	1	73	10	100
Cpd 1 + Cartap	4 + 0.1	33	14 + 0.1	47	50 + 0.1	67
Cpd 1 + Cartap	4 + 1	60	14 + 1	73	50 + 1	47
Cpd 1 + Cartap	4 + 10	100	14 + 10	100	50 + 10	100
Esfenvalerate	0.5	47	1	80	2	27
Cpd 1 + Esfenvalerate	4 + 0.5	20	14 + 0.5	67*	50 + 0.5	73
Cpd 1 + Esfenvalerate	4 + 1	67	14 + 1	87	50 + 1	93
Cpd 1 + Esfenvalerate	4 + 2	87*	14 + 2	53	50 + 2	93*

Potato Leaf Hopper	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Thiacloprid	0.2	73	0.5	93	1.5	80
Cpd 1 + Thiacloprid	4 + 0.2	27	14 + 0.2	53	50 + 0.2	100*
Cpd 1 + Thiacloprid	4 + 0.5	53	14 + 0.5	80	50 + 0.5	80
Cpd 1 + Thiacloprid	4 + 1.5	100*	14 + 1.5	100*	50 + 1.5	100*
Lambda-cyhalothrin	0.016	73	0.08	0	0.4	87
Cpd 1 + Lambda-cyhalothrin	4 + 0.016	47	14 + 0.016	100*	50 + 0.016	100*
Cpd 1 + Lambda-cyhalothrin	4 + 0.08	47*	14 + 0.08	93*	50 + 0.08	87*
Cpd 1 + Lambda-cyhalothrin	4 + 0.4	100*	14 + 0.4	100*	50 + 0.4	100*
Hydramethylnon	0.01	0	1	27	2	60
Cpd 1 + Hydramethylnon	4 + 0.01	27	14 + 0.01	53*	50 + 0.01	87*
Cpd 1 + Hydramethylnon	4 + 1	20	14 + 1	73*	50 + 1	100*
Cpd 1 + Hydramethylnon	4 + 2	40	14 + 2	87*	50 + 2	100*
Clothianidin	10	93	100	100	1000	100
Cpd 1 + Clothianidin	4 + 10	100	14 + 10	100	50 + 10	100
Cpd 1 + Clothianidin	4 + 100	100	14 + 100	100	50 + 100	100
Cpd 1 + Clothianidin	4 + 1000	100	14 + 1000	100	50 + 1000	100
Lufenuron	0.08	40	0.4	53	2	40
Cpd 1 + Lufenuron	4 + 0.08	60*	14 + 0.08	87*	50 + 0.08	87*
Cpd 1 + Lufenuron	4 + 0.4	47	14 + 0.4	67	50 + 0.4	73
Cpd 1 + Lufenuron	4 + 2	47	14 + 2	27	50 + 2	100*
Abamectin	10	47	100	100	1000	100
Cpd 1 + Abamectin	4 + 10	87*	14 + 10	93*	50 + 10	93*
Cpd 1 + Abamectin	4 + 100	100	14 + 100	100	50 + 100	100
Cpd 1 + Abamectin	4 + 1000	100	14 + 1000	100	50 + 1000	100
Methoxyfenozide	0.08	13	0.4	13	2	20
Cpd 1 + Methoxyfenozide	4 + 0.08	13	14 + 0.08	73*	50 + 0.08	100*
Cpd 1 + Methoxyfenozide	4 + 0.4	13	14 + 0.4	7	50 + 0.4	100*
Cpd 1 + Methoxyfenozide	4 + 2	27	14 + 2	100*	50 + 2	100*
Nitenpyram	0.3	7	0.4	73	0.5	33
Cpd 1 + Nitenpyram	4 + 0.3	7	14 + 0.3	100*	50 + 0.3	100*
Cpd 1 + Nitenpyram	4 + 0.4	7	14 + 0.4	100*	50 + 0.4	13
Cpd 1 + Nitenpyram	4 + 0.5	7	14 + 0.5	100*	50 + 0.5	13
Pyridalyl	0.5	13	5	13	50	7
Cpd 1 + Pyridalyl	4 + 0.5	7	14 + 0.5	7	50 + 0.5	20

Potato Leaf Hopper	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Pyridalyl	4 + 5	0	14 + 5	13	50 + 5	7
Cpd 1 + Pyridalyl	4 + 50	13	14 + 50	13	50 + 50	7
Dinotefuran	0.02	7	0.08	7	0.4	47
Cpd 1 + Dinotefuran	4 + 0.02	7	14 + 0.02	53*	50 + 0.02	100*
Cpd 1 + Dinotefuran	4 + 0.08	7	14 + 0.08	67*	50 + 0.08	100*
Cpd 1 + Dinotefuran	4 + 0.4	100*	14 + 0.4	100*	50 + 0.4	100*
Novaluron	250	7	500	7	1000	0
Cpd 1 + Novaluron	4 + 250	7	14 + 250	60*	50 + 250	67*
Cpd 1 + Novaluron	4 + 500	13	14 + 500	67*	50 + 500	100*
Cpd 1 + Novaluron	4 + 1000	47*	14 + 1000	67*	50 + 1000	93*

TEST D

For evaluating control of corn planthopper (*Peregrinus maidis*) through contact and/or systemic means, each test unit consisted of a small open cylindrical container with a 3- to 4-day-old corn (maize) plant (spike) inside. White sand was added to the top of the soil prior to application. Test compounds were formulated and sprayed with 3 replications as described for Test A. After spraying, the test units were allowed to dry for 1 hour before they were post-infested with 10 to 20 corn planthoppers (18- to 20-day-old nymphs) by sprinkling them onto the sand with a salt shaker. A black, screened cap was placed on the top of each container. The test units were held for 6 days in a growth chamber at 19–21 °C and 50–70% relative humidity. Each test unit was then visually assessed for insect mortality; the results are listed in Tables 5A and 5B.

Table 5A

Corn Planthopper				
Compound 1 (ppm)	Imidacloprid (ppm)	Ratio	% Mortality (observed)	% Mortality (calculated)
5	0	-	6	-
50	0	-	9	-
150	0	-	28	-
0	0.1	-	27	-
0	0.3	-	37	-
0	1	-	60	-
5	0.1	50:1	7	31
5	0.3	16.7:1	8	41
5	1	5:1	15	62

Corn Planthopper				
Compound 1 (ppm)	Imidacloprid (ppm)	Ratio	% Mortality (observed)	% Mortality (calculated)
50	0.1	500:1	9	34
50	0.3	167:1	5	43
50	1	50:1	13	64
150	0.1	1500:1	8	47
150	0.3	500:1	5	55
150	1	150:1	13	71

Table 5B

* indicates the observed % mortality is higher than the calculated % mortality by Colby equation.

Corn Plant Hopper	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Compound 1	20	15	100	19	500	28
Methomyl	0.5	5	1	21	2	19
Cpd 1 + Methomyl	20 + 0.5	5	100 + 0.5	23	500 + 0.5	6
Cpd 1 + Methomyl	20 + 1	7	100 + 1	36	500 + 1	2
Cpd 1 + Methomyl	20 + 2	2	100 + 2	34	500 + 2	8
Amitraz	5	6	10	3	50	5
Cpd 1 + Amitraz	20 + 5	2	100 + 5	6	500 + 5	9
Cpd 1 + Amitraz	20 + 10	7	100 + 10	3	500 + 10	9
Cpd 1 + Amitraz	20 + 50	11	100 + 50	8	500 + 50	10
Thiamethoxam	0.2	100	0.4	100	0.6	100
Cpd 1 + Thiamethoxam	20 + 0.2	100	100 + 0.2	73	500 + 0.2	98
Cpd 1 + Thiamethoxam	20 + 0.4	100	100 + 0.4	100	500 + 0.4	100
Cpd 1 + Thiamethoxam	20 + 0.6	100	100 + 0.6	100	500 + 0.6	100
Pyridaben	2	10	2.5	2	3	2
Cpd 1 + Pyridaben	20 + 2	57*	100 + 2	14	500 + 2	2
Cpd 1 + Pyridaben	20 + 2.5	48*	100 + 2.5	16	500 + 2.5	5
Cpd 1 + Pyridaben	20 + 3	19*	100 + 3	17	500 + 3	4
Flonicamid	2	52	15	42	150	90
Cpd 1 + Flonicamid	20 + 2	100*	100 + 2	31	500 + 2	68
Cpd 1 + Flonicamid	20 + 15	100*	100 + 15	50	500 + 15	100*
Cpd 1 + Flonicamid	20 + 150	59	100 + 150	42	500 + 150	100
Dieldrin	0.1	37	0.2	57	0.3	71
Cpd 1 + Dieldrin	20 + 0.1	32	100 + 0.1	92*	500 + 0.1	98*

Corn Plant Hopper	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Dieldrin	20 + 0.2	88*	100 + 0.2	88*	500 + 0.2	10
Cpd 1 + Dieldrin	20 + 0.3	36	100 + 0.3	100*	500 + 0.3	92*
Spinosad	5	100	10	100	20	100
Cpd 1 + Spinosad	20 + 5	100	100 + 5	100	500 + 5	100
Cpd 1 + Spinosad	20 + 10	100	100 + 10	100	500 + 10	100
Cpd 1 + Spinosad	20 + 20	100	100 + 20	100	500 + 20	100
Fipronil	0.5	5	1	41	1.5	15
Cpd 1 + Fipronil	20 + 0.5	29*	100 + 0.5	5	500 + 0.5	6
Cpd 1 + Fipronil	20 + 1	22	100 + 1	7	500 + 1	11
Cpd 1 + Fipronil	20 + 1.5	15	100 + 1.5	9	500 + 1.5	8
Pyriproxyfen	10	0	100	8	1000	12
Cpd 1 + Pyriproxyfen	20 + 10	9	100 + 10	17	500 + 10	14
Cpd 1 + Pyriproxyfen	20 + 100	28*	100 + 100	10	500 + 100	6
Cpd 1 + Pyriproxyfen	20 + 1000	11	100 + 1000	5	500 + 1000	3
Pymetrozine	2	51	10	29	30	89
Cpd 1 + Pymetrozine	20 + 2	20	100 + 2	32	500 + 2	62
Cpd 1 + Pymetrozine	20 + 10	50*	100 + 10	58*	500 + 10	84*
Cpd 1 + Pymetrozine	20 + 30	81	100 + 30	89	500 + 30	100*
Buprofezin	10	96	100	97	1000	98
Cpd 1 + Buprofezin	20 + 10	92	100 + 10	86	500 + 10	89
Cpd 1 + Buprofezin	20 + 100	94	100 + 100	90	500 + 100	98
Cpd 1 + Buprofezin	20 + 1000	93	100 + 1000	80	500 + 1000	96
Chlorfenapyr	1.5	31	2.5	15	3.5	11
Cpd 1 + Chlorfenapyr	20 + 1.5	68*	100 + 1.5	41	500 + 1.5	64*
Cpd 1 + Chlorfenapyr	20 + 2.5	18	100 + 2.5	42*	500 + 2.5	38
Cpd 1 + Chlorfenapyr	20 + 3.5	34*	100 + 3.5	39*	500 + 3.5	8
Chlorpyrifos	0.1	46	0.2	24	0.3	19
Cpd 1 + Chlorpyrifos	20 + 0.1	40	100 + 0.1	29	500 + 0.1	53
Cpd 1 + Chlorpyrifos	20 + 0.2	47*	100 + 0.2	20	500 + 0.2	33
Cpd 1 + Chlorpyrifos	20 + 0.3	14	100 + 0.3	50*	500 + 0.3	58*
Cyromazine	200	4	500	8	1000	8
Cpd 1 + Cyromazine	20 + 200	8	100 + 200	4	500 + 200	30
Cpd 1 + Cyromazine	20 + 500	20	100 + 500	8	500 + 500	17
Cpd 1 + Cyromazine	20 + 1000	6	100 + 1000	40*	500 + 1000	15

Corn Plant Hopper	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Fenoxycarb	10	8	100	2	1000	5
Cpd 1 + Fenoxycarb	20 + 10	24	100 + 10	86*	500 + 10	96*
Cpd 1 + Fenoxycarb	20 + 100	49*	100 + 100	78*	500 + 100	100*
Cpd 1 + Fenoxycarb	20 + 1000	19	100 + 1000	74*	500 + 1000	61*
Methoprene	15	100	50	65	150	86
Cpd 1 + Methoprene	20 + 15	100	100 + 15	73	500 + 15	100
Cpd 1 + Methoprene	20 + 50	16	100 + 50	17	500 + 50	93*
Cpd 1 + Methoprene	20 + 150	74	100 + 150	2	500 + 150	87
Indoxacarb	50	3	500	4	3000	18
Cpd 1 + Indoxacarb	20 + 50	10	100 + 50	4	500 + 50	100*
Cpd 1 + Indoxacarb	20 + 500	2	100 + 500	30	500 + 500	100*
Cpd 1 + Indoxacarb	20 + 3000	4	100 + 3000	6	500 + 3000	100*
Triazamate	50	5	75	94	100	94
Cpd 1 + Triazamate	20 + 50	100*	100 + 50	73*	500 + 50	100*
Cpd 1 + Triazamate	20 + 75	100*	100 + 75	63	500 + 75	12
Cpd 1 + Triazamate	20 + 100	7	100 + 100	94	500 + 100	6
Thiodicarb	0.08	2	0.16	6	0.4	7
Cpd 1 + Thiodicarb	20 + 0.08	3	100 + 0.08	40*	500 + 0.08	13
Cpd 1 + Thiodicarb	20 + 0.16	5	100 + 0.16	2	500 + 0.16	11
Cpd 1 + Thiodicarb	20 + 0.4	2	100 + 0.4	4	500 + 0.4	5
Tebufenozide	100	12	1000	16	3000	12
Cpd 1 + Tebufenozide	20 + 100	6	100 + 100	15	500 + 100	9
Cpd 1 + Tebufenozide	20 + 1000	8	100 + 1000	80*	500 + 1000	38
Cpd 1 + Tebufenozide	20 + 3000	7	100 + 3000	7	500 + 3000	44*
Deltamethrin	0.1	11	0.2	14	0.3	7
Cpd 1 + Deltamethrin	20 + 0.1	11	100 + 0.1	8	500 + 0.1	13
Cpd 1 + Deltamethrin	20 + 0.2	12	100 + 0.2	14	500 + 0.2	100*
Cpd 1 + Deltamethrin	20 + 0.3	6	100 + 0.3	100*	500 + 0.3	100*
Oxamyl	0.08	2	0.16	5	0.2	6
Cpd 1 + Oxamyl	20 + 0.08	2	100 + 0.08	7	500 + 0.08	8
Cpd 1 + Oxamyl	20 + 0.16	8	100 + 0.16	2	500 + 0.16	3
Cpd 1 + Oxamyl	20 + 0.2	7	100 + 0.2	6	500 + 0.2	7
Hexaflumuron	100	6	1000	5	3000	4
Cpd 1 + Hexaflumuron	20 + 100	2	100 + 100	2	500 + 100	11

Corn Plant Hopper	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Hexaflumuron	20 + 1000	11	100 + 1000	13	500 + 1000	14
Cpd 1 + Hexaflumuron	20 + 3000	8	100 + 3000	11	500 + 3000	7
Acetamiprid	0.3	43	0.4	85	0.5	100
Cpd 1 + Acetamiprid	20 + 0.3	3	100 + 0.3	6	500 + 0.3	7
Cpd 1 + Acetamiprid	20 + 0.4	14	100 + 0.4	86	500 + 0.4	100*
Cpd 1 + Acetamiprid	20 + 0.5	41	100 + 0.5	100	500 + 0.5	100*
Cartap	0.3	100	3	100	30	100
Cpd 1 + Cartap	20 + 0.3	100	100 + 0.3	100	500 + 0.3	100
Cpd 1 + Cartap	20 + 3	100	100 + 3	100	500 + 3	100
Cpd 1 + Cartap	20 + 30	100	100 + 30	100	500 + 30	100
Esfenvalerate	0.1	7	0.3	6	0.9	6
Cpd 1 + Esfenvalerate	20 + 0.1	9	100 + 0.1	3	500 + 0.1	6
Cpd 1 + Esfenvalerate	20 + 0.3	4	100 + 0.3	4	500 + 0.3	2
Cpd 1 + Esfenvalerate	20 + 0.9	5	100 + 0.9	7	500 + 0.9	10
Thiacloprid	0.3	6	3	100	30	100
Cpd 1 + Thiacloprid	20 + 0.3	81*	100 + 0.3	100*	500 + 0.3	100*
Cpd 1 + Thiacloprid	20 + 3	100	100 + 3	100	500 + 3	100
Cpd 1 + Thiacloprid	20 + 30	100	100 + 30	100	500 + 30	100
Lambda-cyhalothrin	0.016	7	0.08	7	0.4	28
Cpd 1 + Lambda-cyhalothrin	20 + 0.016	9	100 + 0.016	12	500 + 0.016	51
Cpd 1 + Lambda-cyhalothrin	20 + 0.08	9	100 + 0.08	7	500 + 0.08	11
Cpd 1 + Lambda-cyhalothrin	20 + 0.4	34	100 + 0.4	57	500 + 0.4	16
Hydramethylnon	0.01	7	1	1	2	6
Cpd 1 + Hydramethylnon	20 + 0.01	19	100 + 0.01	7	500 + 0.01	5
Cpd 1 + Hydramethylnon	20 + 1	6	100 + 1	8	500 + 1	7
Cpd 1 + Hydramethylnon	20 + 2	14	100 + 2	13	500 + 2	11
Clothianidin	10	100	100	100	1000	100
Cpd 1 + Clothianidin	20 + 10	100	100 + 10	100	500 + 10	100
Cpd 1 + Clothianidin	20 + 100	100	100 + 100	100	500 + 100	100
Cpd 1 + Clothianidin	20 + 1000	100	100 + 1000	100	500 + 1000	100
Lufenuron	0.08	9	0.4	7	2	7
Cpd 1 + Lufenuron	20 + 0.08	5	100 + 0.08	7	500 + 0.08	2
Cpd 1 + Lufenuron	20 + 0.4	9	100 + 0.4	5	500 + 0.4	2
Cpd 1 + Lufenuron	20 + 2	20	100 + 2	6	500 + 2	11

Corn Plant Hopper	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Abamectin	1.6	7	8	93	40	100
Cpd 1 + Abamectin	20 + 1.6	17	100 + 1.6	10	500 + 1.6	6
Cpd 1 + Abamectin	20 + 8	19	100 + 8	100*	500 + 8	56
Cpd 1 + Abamectin	20 + 40	100	100 + 40	100	500 + 40	100
Methoxyfenozide	10	7	100	2	1000	10
Cpd 1 + Methoxyfenozide	20 + 10	3	100 + 10	10	500 + 10	7
Cpd 1 + Methoxyfenozide	20 + 100	2	100 + 100	5	500 + 100	13
Cpd 1 + Methoxyfenozide	20 + 1000	10	100 + 1000	4	500 + 1000	11
Nitenpyram	0.1	27	0.2	100	0.3	100
Cpd 1 + Nitenpyram	20 + 0.1	16	100 + 0.1	100*	500 + 0.1	15
Cpd 1 + Nitenpyram	20 + 0.2	100	100 + 0.2	100	500 + 0.2	100
Cpd 1 + Nitenpyram	20 + 0.3	100	100 + 0.3	100	500 + 0.3	100
Pyridalyl	10	2	100	6	1000	11
Cpd 1 + Pyridalyl	20 + 10	7	100 + 10	13	500 + 10	66*
Cpd 1 + Pyridalyl	20 + 100	4	100 + 100	10	500 + 100	48*
Cpd 1 + Pyridalyl	20 + 1000	9	100 + 1000	61*	500 + 1000	38
Dinotefuran	0.02	5	0.08	5	0.4	86
Cpd 1 + Dinotefuran	20 + 0.02	6	100 + 0.02	4	500 + 0.02	100*
Cpd 1 + Dinotefuran	20 + 0.08	8	100 + 0.08	68	500 + 0.08	100*
Cpd 1 + Dinotefuran	20 + 0.4	89	100 + 0.4	100*	500 + 0.4	100*
Novaluron	250	7	500	5	1000	100
Cpd 1 + Novaluron	20 + 250	7	100 + 250	6	500 + 250	6
Cpd 1 + Novaluron	20 + 500	7	100 + 500	2	500 + 500	6
Cpd 1 + Novaluron	20 + 1000	4	100 + 1000	9	500 + 1000	16

TEST E

For evaluating control of cotton melon aphid (*Aphis gossypii* Glover) through contact and/or systemic means, each test unit consisted of a small open container with a 6- to 7-day-old cotton plant inside. This was pre-infested by placing on a leaf of the test plant 30 to 40 aphids on a piece of leaf excised from a culture plant (cut-leaf method). The larvae moved onto the test plant as the leaf piece desiccated. After pre-infestation, the soil of the test unit was covered with a layer of sand.

Test compounds were formulated and sprayed as described for Test A. The applications were replicated three times. After spraying of the formulated test compounds, each test unit was allowed to dry for 1 hour and then a black, screened cap was placed on

top. The test units were held for 6 days in a growth chamber at 19–21 °C and 50–70% relative humidity. Each test unit was then visually assessed for insect mortality; the results are listed in Tables 6A and 6B.

Table 6A

Cotton/ Melon Aphid				
Compound 1 (ppm)	Imidacloprid (ppm)	Ratio	% Mortality (observed)	% Mortality (calculated)
0.8	0	-	12	-
4.5	0	-	32	-
25	0	-	23	-
0	0.05	-	12	-
0	0.3	-	10	-
0	2.1	-	40	-
0.8	0.05	16:1	14	23
0.8	0.3	2.7:1	26	21
0.8	2.1	1:2.6	97	47
4.5	0.05	90:1	38	40
4.5	0.3	15:1	67	39
4.5	2.1	2.1:1	100	59
25	0.05	500:1	81	32
25	0.3	83:1	82	31
25	2.1	11.9:1	97	54

Table 6B

* indicates the observed % mortality is higher than the calculated % mortality by Colby equation.

Cotton/Melon Aphid	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Compound 1	4	25	20	41	100	49
Methomyl	2	11	5	35	15	64
Cpd 1 + Methomyl	4 + 2	13	20 + 2	51	100 + 2	29
Cpd 1 + Methomyl	4 + 5	23	20 + 5	47	100 + 5	68
Cpd 1 + Methomyl	4 + 15	75	20 + 15	81	100 + 15	98*
Amitraz	10	20	100	35	1000	29
Cpd 1 + Amitraz	4 + 10	54*	20 + 10	54	100 + 10	73*
Cpd 1 + Amitraz	4 + 100	48	20 + 100	85*	100 + 100	90*
Cpd 1 + Amitraz	4 + 1000	50	20 + 1000	77*	100 + 1000	89*
Thiamethoxam	0.2	24	0.4	48	0.6	66
Cpd 1 + Thiamethoxam	4 + 0.2	46	20 + 0.2	33	100 + 0.2	100*

Cotton/Melon Aphid	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Thiamethoxam	4 + 0.4	61	20 + 0.4	65*	100 + 0.4	100*
Cpd 1 + Thiamethoxam	4 + 0.6	98*	20 + 0.6	92*	100 + 0.6	100*
Pyridaben	1	11	2	15	10	71
Cpd 1 + Pyridaben	4 + 1	33	20 + 1	41	100 + 1	95*
Cpd 1 + Pyridaben	4 + 2	21	20 + 2	53	100 + 2	89*
Cpd 1 + Pyridaben	4 + 10	47	20 + 10	73	100 + 10	100*
Flonicamid	0.2	9	1	46	5	92
Cpd 1 + Flonicamid	4 + 0.2	96*	20 + 0.2	69*	100 + 0.2	64*
Cpd 1 + Flonicamid	4 + 1	71*	20 + 1	72*	100 + 1	94*
Cpd 1 + Flonicamid	4 + 5	100*	20 + 5	86	100 + 5	100*
Dieldrin	1	13	5	26	50	66
Cpd 1 + Dieldrin	4 + 1	49*	20 + 1	83*	100 + 1	70*
Cpd 1 + Dieldrin	4 + 5	58*	20 + 5	92*	100 + 5	74*
Cpd 1 + Dieldrin	4 + 50	98*	20 + 50	100*	100 + 50	100*
Spinosad	10	16	100	35	1000	30
Cpd 1 + Spinosad	4 + 10	51*	20 + 10	39	100 + 10	46
Cpd 1 + Spinosad	4 + 100	40	20 + 100	62	100 + 100	54
Cpd 1 + Spinosad	4 + 1000	77*	20 + 1000	54	100 + 1000	65
Fipronil	2	27	4	44	8	85
Cpd 1 + Fipronil	4 + 2	27	20 + 2	64*	100 + 2	81*
Cpd 1 + Fipronil	4 + 4	44	20 + 4	89*	100 + 4	83*
Cpd 1 + Fipronil	4 + 8	85*	20 + 8	81	100 + 8	98*
Pyriproxyfen	10	14	100	28	1000	33
Cpd 1 + Pyriproxyfen	4 + 10	38	20 + 10	25	100 + 10	69*
Cpd 1 + Pyriproxyfen	4 + 100	22	20 + 100	53	100 + 100	56
Cpd 1 + Pyriproxyfen	4 + 1000	25	20 + 1000	59	100 + 1000	95*
Pymetrozine	0.1	22	0.5	38	2	62
Cpd 1 + Pymetrozine	4 + 0.1	29	20 + 0.1	82*	100 + 0.1	57
Cpd 1 + Pymetrozine	4 + 0.5	35	20 + 0.5	38	100 + 0.5	93*
Cpd 1 + Pymetrozine	4 + 2	73	20 + 2	88*	100 + 2	100*
Buprofezin	10	34	100	30	1000	36
Cpd 1 + Buprofezin	4 + 10	34	20 + 10	24	100 + 10	56
Cpd 1 + Buprofezin	4 + 100	41	20 + 100	31	100 + 100	76*
Cpd 1 + Buprofezin	4 + 1000	31	20 + 1000	32	100 + 1000	78*

Cotton/Melon Aphid	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Chlorfenapyr	1	27	10	57	150	67
Cpd 1 + Chlorfenapyr	4 + 1	29	20 + 1	52	100 + 1	38
Cpd 1 + Chlorfenapyr	4 + 10	43	20 + 10	51	100 + 10	75
Cpd 1 + Chlorfenapyr	4 + 150	100*	20 + 150	96*	100 + 150	100*
Chlorpyrifos	1	26	5	14	50	13
Cpd 1 + Chlorpyrifos	4 + 1	19	20 + 1	46	100 + 1	74*
Cpd 1 + Chlorpyrifos	4 + 5	34	20 + 5	49	100 + 5	65*
Cpd 1 + Chlorpyrifos	4 + 50	25	20 + 50	32	100 + 50	64*
Cyromazine	10	23	100	34	1000	28
Cpd 1 + Cyromazine	4 + 10	25	20 + 10	60	100 + 10	49
Cpd 1 + Cyromazine	4 + 100	29	20 + 100	34	100 + 100	79
Cpd 1 + Cyromazine	4 + 1000	23	20 + 1000	41	100 + 1000	60
Fenoxycarb	10	16	100	23	1000	34
Cpd 1 + Fenoxycarb	4 + 10	29	20 + 10	72*	100 + 10	78*
Cpd 1 + Fenoxycarb	4 + 100	25	20 + 100	50	100 + 100	87*
Cpd 1 + Fenoxycarb	4 + 1000	60*	20 + 1000	72*	100 + 1000	75*
Methoprene	10	43	100	53	1000	50
Cpd 1 + Methoprene	4 + 10	44	20 + 10	91*	100 + 10	100*
Cpd 1 + Methoprene	4 + 100	50	20 + 100	73	100 + 100	100*
Cpd 1 + Methoprene	4 + 1000	45	20 + 1000	96*	100 + 1000	100*
Indoxacarb	10	16	20	28	30	34
Cpd 1 + Indoxacarb	4 + 10	32	20 + 10	51	100 + 10	48
Cpd 1 + Indoxacarb	4 + 20	35	20 + 20	47	100 + 20	67
Cpd 1 + Indoxacarb	4 + 30	35	20 + 30	47	100 + 30	75*
Triazamate	2	17	20	59	100	100
Cpd 1 + Triazamate	4 + 2	20	20 + 2	18	100 + 2	33
Cpd 1 + Triazamate	4 + 20	53	20 + 20	43	100 + 20	58
Cpd 1 + Triazamate	4 + 100	96	20 + 100	100	100 + 100	100
Thiodicarb	3	49	10	32	30	69
Cpd 1 + Thiodicarb	4 + 3	33	20 + 3	37	100 + 3	51
Cpd 1 + Thiodicarb	4 + 10	36	20 + 10	43	100 + 10	54
Cpd 1 + Thiodicarb	4 + 30	35	20 + 30	80	100 + 30	96*
Tebufenozide	0.5	21	1.5	37	3	22
Cpd 1 + Tebufenozide	4 + 0.5	36	20 + 0.5	49	100 + 0.5	61

Cotton/Melon Aphid	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Tebufenozide	4 + 1.5	39	20 + 1.5	57	100 + 1.5	85*
Cpd 1 + Tebufenozide	4 + 3	42	20 + 3	45	100 + 3	83*
Deltamethrin	0.1	52	0.2	39	0.3	88
Cpd 1 + Deltamethrin	4 + 0.1	28	20 + 0.1	29	100 + 0.1	58
Cpd 1 + Deltamethrin	4 + 0.2	28	20 + 0.2	31	100 + 0.2	46
Cpd 1 + Deltamethrin	4 + 0.3	47	20 + 0.3	52	100 + 0.3	45
Oxamyl	1	29	10	37	1000	100
Cpd 1 + Oxamyl	4 + 1	35	20 + 1	61*	100 + 1	75*
Cpd 1 + Oxamyl	4 + 10	47	20 + 10	71*	100 + 10	77*
Cpd 1 + Oxamyl	4 + 1000	100	20 + 1000	100	100 + 1000	100
Hexaflumuron	30	32	1000	30	3000	29
Cpd 1 + Hexaflumuron	4 + 30	40	20 + 30	60	100 + 30	47
Cpd 1 + Hexaflumuron	4 + 1000	74*	20 + 1000	65*	100 + 1000	70*
Cpd 1 + Hexaflumuron	4 + 3000	42	20 + 3000	60*	100 + 3000	69*
Acetamiprid	0.02	42	0.08	67	0.4	100
Cpd 1 + Acetamiprid	4 + 0.02	41	20 + 0.02	49	100 + 0.02	62
Cpd 1 + Acetamiprid	4 + 0.08	55	20 + 0.08	85*	100 + 0.08	86*
Cpd 1 + Acetamiprid	4 + 0.4	94	20 + 0.4	85	100 + 0.4	100
Cartap	0.2	29	2	34	200	83
Cpd 1 + Cartap	4 + 0.2	79*	20 + 0.2	86*	100 + 0.2	83*
Cpd 1 + Cartap	4 + 2	64*	20 + 2	56	100 + 2	55
Cpd 1 + Cartap	4 + 200	91*	20 + 200	86	100 + 200	100*
Esfenvalerate	0.1	95	0.3	94	1	100
Cpd 1 + Esfenvalerate	4 + 0.1	75	20 + 0.1	88	100 + 0.1	96
Cpd 1 + Esfenvalerate	4 + 0.3	82	20 + 0.3	81	100 + 0.3	87
Cpd 1 + Esfenvalerate	4 + 1	75	20 + 1	91	100 + 1	100
Thiacloprid	0.3	50	1.5	100	6	100
Cpd 1 + Thiacloprid	4 + 0.3	64	20 + 0.3	84*	100 + 0.3	94*
Cpd 1 + Thiacloprid	4 + 1.5	96	20 + 1.5	100	100 + 1.5	96
Cpd 1 + Thiacloprid	4 + 6	100	20 + 6	100	100 + 6	100
Lambda-cyhalothrin	0.08	22	0.4	81	2	100
Cpd 1 + Lambda-cyhalothrin	4 + 0.08	39	20 + 0.08	66*	100 + 0.08	63
Cpd 1 + Lambda-cyhalothrin	4 + 0.4	100*	20 + 0.4	84	100 + 0.4	100*
Cpd 1 + Lambda-cyhalothrin	4 + 2	100	20 + 2	100	100 + 2	100

Cotton/Melon Aphid	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Hydramethylnon	500	21	1000	40	1500	39
Cpd 1 + Hydramethylnon	4 + 500	39	20 + 500	75*	100 + 500	67*
Cpd 1 + Hydramethylnon	4 + 1000	53	20 + 1000	66	100 + 1000	69
Cpd 1 + Hydramethylnon	4 + 1500	54	20 + 1500	66	100 + 1500	77*
Clothianidin	0.08	75	0.4	91	2	99
Cpd 1 + Clothianidin	4 + 0.08	94*	20 + 0.08	84	100 + 0.08	92
Cpd 1 + Clothianidin	4 + 0.4	92	20 + 0.4	88	100 + 0.4	100
Cpd 1 + Clothianidin	4 + 2	100	20 + 2	100	100 + 2	100
Lufenuron	0.08	28	0.4	39	2	58
Cpd 1 + Lufenuron	4 + 0.08	37	20 + 0.08	55	100 + 0.08	51
Cpd 1 + Lufenuron	4 + 0.4	34	20 + 0.4	66	100 + 0.4	53
Cpd 1 + Lufenuron	4 + 2	40	20 + 2	65	100 + 2	54
Abamectin	0.08	35	0.4	58	2	100
Cpd 1 + Abamectin	4 + 0.08	43	20 + 0.08	59	100 + 0.08	82*
Cpd 1 + Abamectin	4 + 0.4	100*	20 + 0.4	100*	100 + 0.4	93*
Cpd 1 + Abamectin	4 + 2	100	20 + 2	100	100 + 2	94
Methoxyfenozide	5	32	50	54	500	38
Cpd 1 + Methoxyfenozide	4 + 5	32	20 + 5	62*	100 + 5	57
Cpd 1 + Methoxyfenozide	4 + 50	54*	20 + 50	46	100 + 50	62
Cpd 1 + Methoxyfenozide	4 + 500	38	20 + 500	50	100 + 500	54
Nitenpyram	0.2	29	0.4	49	0.6	71
Cpd 1 + Nitenpyram	4 + 0.2	27	20 + 0.2	71*	100 + 0.2	26
Cpd 1 + Nitenpyram	4 + 0.4	55	20 + 0.4	94*	100 + 0.4	72
Cpd 1 + Nitenpyram	4 + 0.6	62	20 + 0.6	100*	100 + 0.6	95*
Pyridalyl	1	22	1.5	34	2	32
Cpd 1 + Pyridalyl	4 + 1	30	20 + 1	43	100 + 1	51
Cpd 1 + Pyridalyl	4 + 1.5	42	20 + 1.5	55	100 + 1.5	66
Cpd 1 + Pyridalyl	4 + 2	33	20 + 2	59	100 + 2	64
Dinotefuran	1	31	2	64	5	92
Cpd 1 + Dinotefuran	4 + 1	20	20 + 1	62	100 + 1	76*
Cpd 1 + Dinotefuran	4 + 2	45	20 + 2	82	100 + 2	89
Cpd 1 + Dinotefuran	4 + 5	100	20 + 5	96	100 + 5	96
Novaluron	50	28	250	30	1000	29
Cpd 1 + Novaluron	4 + 50	34	20 + 50	70*	100 + 50	78*

Cotton/Melon Aphid	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Novaluron	4 + 250	52*	20 + 250	89*	100 + 250	84*
Cpd 1 + Novaluron	4 + 1000	48*	20 + 1000	89*	100 + 1000	86*

TEST F

For evaluating control of green peach aphid (*Myzus persicae* Sulzer) through contact and/or systemic means, each test unit consisted of a small open container with a 12- to 15-day-old radish plant inside. This was pre-infested by placing on a leaf of the test plant 30 to 40 aphids on a piece of leaf excised from a culture plant (cut-leaf method). The larvae moved onto the test plant as the leaf piece desiccated. After pre-infestation, the soil of the test unit was covered with a layer of sand.

Test compounds were formulated and sprayed as described in Test A, replicated three times. After spraying of the formulated test compound, each test unit was allowed to dry for 1 hour and then a black, screened cap was placed on top. The test units were held for 6 days in a growth chamber at 19–21 °C and 50–70% relative humidity. Each test unit was then visually assessed for insect mortality; the results are listed in Tables 7A and 7B.

Table 7A

Green Peach Aphid				
Compound 1 (ppm)	Imidacloprid (ppm)	Ratio	% Mortality (observed)	% Mortality (calculated)
2.1	0	-	5	-
3.9	0	-	2	-
7.5	0	-	6	-
0	0.08	-	4	-
0	0.15	-	12	-
0	0.26	-	50	-
2.1	0.08	26:1	49	9
2.1	0.15	14:1	32	16
2.1	0.26	8.1:1	92	53
3.9	0.08	49:1	46	6
3.9	0.15	26:1	59	14
3.9	0.26	15:1	84	51
7.5	0.08	94:1	51	10
7.5	0.15	50:1	52	17
7.5	0.26	29:1	64	53

Table 7B

* indicates the observed % mortality is higher than the calculated % mortality by Colby equation.

Green Peach Aphid	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Compound 1	10	24	20	35	40	36
Methomyl	50	20	100	61	200	100
Cpd 1 + Methomyl	10 + 50	40	20 + 50	32	40 + 50	35
Cpd 1 + Methomyl	10 + 100	67	20 + 100	80*	40 + 100	79*
Cpd 1 + Methomyl	10 + 200	94	20 + 200	100	40 + 200	100
Amitraz	10	16	100	12	1000	34
Cpd 1 + Amitraz	10 + 10	29	20 + 10	21	40 + 10	56*
Cpd 1 + Amitraz	10 + 100	13	20 + 100	11	40 + 100	28
Cpd 1 + Amitraz	10 + 1000	72*	20 + 1000	63*	40 + 1000	69*
Thiamethoxam	0.2	35	0.4	94	0.6	100
Cpd 1 + Thiamethoxam	10 + 0.2	24	20 + 0.2	17	40 + 0.2	35
Cpd 1 + Thiamethoxam	10 + 0.4	81	20 + 0.4	98*	40 + 0.4	87
Cpd 1 + Thiamethoxam	10 + 0.6	100	20 + 0.6	92	40 + 0.6	100
Pyridaben	1	100	10	14	60	60
Cpd 1 + Pyridaben	10 + 1	11	20 + 1	8	40 + 1	6
Cpd 1 + Pyridaben	10 + 10	29	20 + 10	18	40 + 10	19
Cpd 1 + Pyridaben	10 + 60	42	20 + 60	70	40 + 60	49
Flonicamid	0.1	16	0.2	10	2	33
Cpd 1 + Flonicamid	10 + 0.1	36	20 + 0.1	22	40 + 0.1	43
Cpd 1 + Flonicamid	10 + 0.2	34	20 + 0.2	50*	40 + 0.2	32
Cpd 1 + Flonicamid	10 + 2	66*	20 + 2	81*	40 + 2	79*
Dieldrin	10	59	100	43	1000	41
Cpd 1 + Dieldrin	10 + 10	41	20 + 10	43	40 + 10	28
Cpd 1 + Dieldrin	10 + 100	51	20 + 100	75*	40 + 100	37
Cpd 1 + Dieldrin	10 + 1000	82*	20 + 1000	77*	40 + 1000	86*
Spinosad	10	25	100	46	1000	59
Cpd 1 + Spinosad	10 + 10	37	20 + 10	18	40 + 10	92*
Cpd 1 + Spinosad	10 + 100	48	20 + 100	31	40 + 100	69*
Cpd 1 + Spinosad	10 + 1000	72*	20 + 1000	100*	40 + 1000	16
Fipronil	2	17	4	31	8	50
Cpd 1 + Fipronil	10 + 2	22	20 + 2	34	40 + 2	57*
Cpd 1 + Fipronil	10 + 4	44	20 + 4	31	40 + 4	46

Green Peach Aphid	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Fipronil	10 + 8	28	20 + 8	60	40 + 8	99
Pyriproxyfen	10	23	100	12	1000	26
Cpd 1 + Pyriproxyfen	10 + 10	35	20 + 10	27	40 + 10	40
Cpd 1 + Pyriproxyfen	10 + 100	46*	20 + 100	24	40 + 100	50*
Cpd 1 + Pyriproxyfen	10 + 1000	28	20 + 1000	49	40 + 1000	64*
Pymetrozine	0.1	13	0.5	41	2	79
Cpd 1 + Pymetrozine	10 + 0.1	17	20 + 0.1	57*	40 + 0.1	64*
Cpd 1 + Pymetrozine	10 + 0.5	38	20 + 0.5	79*	40 + 0.5	89*
Cpd 1 + Pymetrozine	10 + 2	94*	20 + 2	100*	40 + 2	85
Buprofezin	10	63	100	63	1000	54
Cpd 1 + Buprofezin	10 + 10	28	20 + 10	41	40 + 10	35
Cpd 1 + Buprofezin	10 + 100	51	20 + 100	53	40 + 100	61
Cpd 1 + Buprofezin	10 + 1000	41	20 + 1000	50	40 + 1000	56
Chlorfenapyr	1.5	22	7	36	35	100
Cpd 1 + Chlorfenapyr	10 + 1.5	39	20 + 1.5	29	40 + 1.5	42
Cpd 1 + Chlorfenapyr	10 + 7	59*	20 + 7	54	40 + 7	54
Cpd 1 + Chlorfenapyr	10 + 35	100	20 + 35	100	40 + 35	100
Chlorpyrifos	10	5	100	18	1000	9
Cpd 1 + Chlorpyrifos	10 + 10	11	20 + 10	12	40 + 10	28
Cpd 1 + Chlorpyrifos	10 + 100	17	20 + 100	20	40 + 100	10
Cpd 1 + Chlorpyrifos	10 + 1000	14	20 + 1000	20	40 + 1000	27
Cyromazine	10	24	100	33	1000	65
Cpd 1 + Cyromazine	10 + 10	18	20 + 10	10	40 + 10	32
Cpd 1 + Cyromazine	10 + 100	18	20 + 100	6	40 + 100	19
Cpd 1 + Cyromazine	10 + 1000	46	20 + 1000	24	40 + 1000	65
Fenoxycarb	10	17	100	16	1000	18
Cpd 1 + Fenoxycarb	10 + 10	13	20 + 10	29	40 + 10	27
Cpd 1 + Fenoxycarb	10 + 100	31	20 + 100	23	40 + 100	64*
Cpd 1 + Fenoxycarb	10 + 1000	19	20 + 1000	39	40 + 1000	54*
Methoprene	10	27	100	23	1000	45
Cpd 1 + Methoprene	10 + 10	15	20 + 10	95*	40 + 10	82*
Cpd 1 + Methoprene	10 + 100	28	20 + 100	44	40 + 100	11
Cpd 1 + Methoprene	10 + 1000	15	20 + 1000	59	40 + 1000	62
Indoxacarb	10	9	20	7	30	8

Green Peach Aphid	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Indoxacarb	10 + 10	10	20 + 10	13	40 + 10	15
Cpd 1 + Indoxacarb	10 + 20	12	20 + 20	20	40 + 20	22
Cpd 1 + Indoxacarb	10 + 30	8	20 + 30	23	40 + 30	26
Triazamate	0.1	1	1	2	100	100
Cpd 1 + Triazamate	10 + 0.1	4	20 + 0.1	5	40 + 0.1	11
Cpd 1 + Triazamate	10 + 1	7	20 + 1	5	40 + 1	10
Cpd 1 + Triazamate	10 + 100	100	20 + 100	100	40 + 100	100
Thiodicarb	20	10	150	17	900	98
Cpd 1 + Thiodicarb	10 + 20	7	20 + 20	18	40 + 20	21
Cpd 1 + Thiodicarb	10 + 150	19	20 + 150	47*	40 + 150	29
Cpd 1 + Thiodicarb	10 + 900	100*	20 + 900	88	40 + 900	100*
Tebufenozide	100	8	1000	7	3000	9
Cpd 1 + Tebufenozide	10 + 100	23	20 + 100	9	40 + 100	13
Cpd 1 + Tebufenozide	10 + 1000	22	20 + 1000	20	40 + 1000	22
Cpd 1 + Tebufenozide	10 + 3000	12	20 + 3000	33	40 + 3000	15
Deltamethrin	250	9	300	3	1000	9
Cpd 1 + Deltamethrin	10 + 250	5	20 + 250	2	40 + 250	10
Cpd 1 + Deltamethrin	10 + 300	6	20 + 300	5	40 + 300	6
Cpd 1 + Deltamethrin	10 + 1000	11	20 + 1000	5	40 + 1000	13
Oxamyl	40	8	70	18	100	35
Cpd 1 + Oxamyl	10 + 40	29	20 + 40	31	40 + 40	28
Cpd 1 + Oxamyl	10 + 70	42*	20 + 70	57*	40 + 70	72*
Cpd 1 + Oxamyl	10 + 100	63*	20 + 100	85*	40 + 100	70*
Hexaflumuron	100	8	1000	6	3000	13
Cpd 1 + Hexaflumuron	10 + 100	19	20 + 100	21	40 + 100	46*
Cpd 1 + Hexaflumuron	10 + 1000	41*	20 + 1000	30	40 + 1000	19
Cpd 1 + Hexaflumuron	10 + 3000	20	20 + 3000	20	40 + 3000	39
Acetamiprid	0.2	27	0.4	52	0.6	46
Cpd 1 + Acetamiprid	10 + 0.2	26	20 + 0.2	31	40 + 0.2	38
Cpd 1 + Acetamiprid	10 + 0.4	59	20 + 0.4	75*	40 + 0.4	66
Cpd 1 + Acetamiprid	10 + 0.6	73*	20 + 0.6	98*	40 + 0.6	98*
Cartap	0.2	11	0.4	26	0.6	17
Cpd 1 + Cartap	10 + 0.2	28	20 + 0.2	13	40 + 0.2	20
Cpd 1 + Cartap	10 + 0.4	21	20 + 0.4	19	40 + 0.4	14

Green Peach Aphid	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Cartap	10 + 0.6	13	20 + 0.6	11	40 + 0.6	26
Esfenvalerate	50	100	1000	41	3000	23
Cpd 1 + Esfenvalerate	10 + 50	10	20 + 50	26	40 + 50	21
Cpd 1 + Esfenvalerate	10 + 1000	47	20 + 1000	24	40 + 1000	32
Cpd 1 + Esfenvalerate	10 + 3000	30	20 + 3000	24	40 + 3000	23
Thiacloprid	0.2	13	0.3	68	0.4	42
Cpd 1 + Thiacloprid	10 + 0.2	30	20 + 0.2	42	40 + 0.2	64*
Cpd 1 + Thiacloprid	10 + 0.3	13	20 + 0.3	41	40 + 0.3	70*
Cpd 1 + Thiacloprid	10 + 0.4	36	20 + 0.4	69*	40 + 0.4	72*
Lambda-cyhalothrin	0.016	14	0.08	15	0.4	30
Cpd 1 + Lambda-cyhalothrin	10 + 0.016	30	20 + 0.016	16	40 + 0.016	15
Cpd 1 + Lambda-cyhalothrin	10 + 0.08	25	20 + 0.08	39	40 + 0.08	9
Cpd 1 + Lambda-cyhalothrin	10 + 0.4	36	20 + 0.4	36	40 + 0.4	16
Hydramethylnon	500	18	1000	8	1500	7
Cpd 1 + Hydramethylnon	10 + 500	23	20 + 500	21	40 + 500	18
Cpd 1 + Hydramethylnon	10 + 1000	25	20 + 1000	24	40 + 1000	59*
Cpd 1 + Hydramethylnon	10 + 1500	18	20 + 1500	28	40 + 1500	27
Clothianidin	0.08	100	0.4	100	2	100
Cpd 1 + Clothianidin	10 + 0.08	100	20 + 0.08	100	40 + 0.08	100
Cpd 1 + Clothianidin	10 + 0.4	100	20 + 0.4	100	40 + 0.4	100
Cpd 1 + Clothianidin	10 + 2	100	20 + 2	100	40 + 2	100
Lufenuron	50	34	250	15	1000	28
Cpd 1 + Lufenuron	10 + 50	29	20 + 50	58*	40 + 50	49
Cpd 1 + Lufenuron	10 + 250	35	20 + 250	48*	40 + 250	75*
Cpd 1 + Lufenuron	10 + 1000	49*	20 + 1000	18	40 + 1000	51
Abamectin	0.08	47	0.4	100	2	100
Cpd 1 + Abamectin	10 + 0.08	59	20 + 0.08	100*	40 + 0.08	42
Cpd 1 + Abamectin	10 + 0.4	100	20 + 0.4	97	40 + 0.4	100
Cpd 1 + Abamectin	10 + 2	100	20 + 2	100	40 + 2	100
Methoxyfenozide	10	7	100	17	1000	6
Cpd 1 + Methoxyfenozide	10 + 10	9	20 + 10	17	40 + 10	16
Cpd 1 + Methoxyfenozide	10 + 100	8	20 + 100	17	40 + 100	19
Cpd 1 + Methoxyfenozide	10 + 1000	21	20 + 1000	19	40 + 1000	29
Nitenpyram	0.2	7	0.4	17	0.6	40

Green Peach Aphid	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Nitenpyram	10 + 0.2	25	20 + 0.2	16	40 + 0.2	10
Cpd 1 + Nitenpyram	10 + 0.4	24	20 + 0.4	60*	40 + 0.4	7
Cpd 1 + Nitenpyram	10 + 0.6	75*	20 + 0.6	52	40 + 0.6	58
Pyridalyl	1	18	10	8	20	3
Cpd 1 + Pyridalyl	10 + 1	7	20 + 1	19	40 + 1	18
Cpd 1 + Pyridalyl	10 + 10	11	20 + 10	17	40 + 10	15
Cpd 1 + Pyridalyl	10 + 20	24	20 + 20	27	40 + 20	27
Dinotefuran	1	24	2	32	5	61
Cpd 1 + Dinotefuran	10 + 1	9	20 + 1	12	40 + 1	61*
Cpd 1 + Dinotefuran	10 + 2	30	20 + 2	27	40 + 2	48
Cpd 1 + Dinotefuran	10 + 5	82*	20 + 5	87*	40 + 5	89*
Novaluron	250	14	500	24	1000	25
Cpd 1 + Novaluron	10 + 250	31	20 + 250	47	40 + 250	25
Cpd 1 + Novaluron	10 + 500	34	20 + 500	29	40 + 500	47
Cpd 1 + Novaluron	10 + 1000	28	20 + 1000	49	40 + 1000	74*

TEST G

For evaluating systemic control of silverleaf whitefly (*Bemisia argentifolii*), each test unit consisted of a 10-inch (25.4 cm) pot with sand, and a tomato plant (var. Tiny Tim) at the 5 to 10 true leaf stage. Oxamyl was in the liquid formulation as Vydate® L and compound **1** was in a wettable powder formulation with 50% active ingredient. Test compounds in approximately 200 mL of water per pot were applied by drip irrigation in the greenhouse. Whitefly activity was evaluated on a naturally occurring population by removing 5 old leaves with clearly visible nymphs. When there were no leaves with clearly visible nymphs, 5 old leaves were removed at random. Leaves were evaluated for dead and live nymphs. For all tests, analysis was conducted by using Fisher's LSD test for means separation, at p=0.05 (see K.A. Gomez and A.A. Gomez, "Statistical Procedures for Agricultural Research", 2nd edition, John Wiley & Sons, New York, 680pp). Mean comparisons were made within each evaluation date only. The results are listed in Table 8.

Table 8

Silverleaf Whitefly							
Compound/mixture	mg	Day 6		Day 13		Day 20	
	ai/pot	Nymphs number	% Mortality	Nymphs number	% Mortality	Nymphs number	% Mortality
Oxamyl	100	380	6	506	34	404	28
Compound 1	20	316	44	194	99	300	100
Oxamyl + Compound 1	100 + 20	228	20	431	70	162	83
Untreated	0	512	1	534	7	53	47

TEST H

For evaluating systemic control of beet armyworm (*Spodoptera exigua*), each test unit consisted of a 10-inch (25.4 cm) pot filled with sand and containing a tomato plant (var. Tiny Tim) at the 5 to 10 true leaf stage. Oxamyl was in the liquid formulation as Vydate® L and compound **1** was in a wettable powder formulation with 50% active ingredient.. Test compounds in approximately 200 mL of water per pot were applied by drip irrigation in the greenhouse. The plants were sampled at indicated date by cutting discs of the leaf material and placing each disc on a layer of agar gel in a 16-well, 1.5 oz. cup tray (B-150-S .028 Natural, Clear Pack Co., Franklin Park, IL 60131). One beet armyworm larva was added to each cell and the cells were covered. Trays were held in the growth chamber at 25°C, 16-hour light:8-hour dark, 60% relative humidity for 4 days. The percentage of mortality (abbreviated as % Morta.) and percentage of feeding (abbreviated as % feed), were visually assessed; the results are listed in Table 9. For all tests, analysis was conducted by using the LSD test. Mean comparisons were made within each evaluation date only.

Table 9

Beet Armyworm							
		Day 6 new & old		Day 13 – old growth		Day 13 – old growth	
Compound/mixture	mg ai/pot	% Morta.	% feed	% Morta.	% feed	% Morta.	% feed
Oxamyl	100	26	49	35	43	40	40
Compound 1	20	99	0	100	0	97	0
Oxamyl + Compound 1	100 + 20	100	0	100	0	100	0
Untreated	0	1	77	0	92	0	61
		Day 20 – new growth		Day 20 – old growth			
Compound/mixture	mg ai/pot	% Morta.	% feed	% Morta.	% feed		
Oxamyl	100	25	92	31	65		
Compound 1	20	100	0	100	0		
Oxamyl + Compound 1	100 + 20	100	0	96	1		
Untreated	0	13	93	61	60		

TEST I

For evaluating control of beet armyworm (*Spodoptera exigua*), methomyl was in the liquid formulation as Lannate® LV (29% of active ingredient). Compound **1** was in a water dispersible granules (WDG) formulation with 35% active ingredient. The test compounds were dissolved in water. Enough water was added to make 100 ppm of active ingredient for each compound. Serial dilutions were made to obtain the appropriate concentrations. To obtain the desired mixture concentrations of each compound, twice the desired concentration of each of the two mixture partner compounds were mixed together in equal volumes.

The diluted solutions of the test compounds were sprayed to run-off on three-week-old tomato plants. The plants were placed on a rotating turntable sprayer (10 rpm). Test solutions were applied using a flat fan air-assisted nozzle (Spraying Systems 122440) at 10 psi (69 kPa). After each treated plant had dried, leaves were excised from the treated plant. The leaves were cut into pieces, which were placed singly into 5.5 cm-by-3.5 cm cells of a sixteen-cell plastic tray. Each cell contained a 2.5-cm square of moistened chromatography paper to prevent desiccation. One insect was placed in each cell. There two trays per treatment. Trays were held in the growth chamber at 25 °C, , 16-hour light:8-hour dark, 60% relative humidity for 4 days. The test was evaluated visually at 72 hours for % of mortality and % feeding; the results are listed in Table 10.

Table 10

Beet Armyworm				
Compound 1 (ppm)	Methomyl (ppm)	ratio	% mortality (observed)	% feeding
0.60	0	-	75	1
0.30	0	-	59	1
0.209	0	-	47	2
0.163	0	-	35	2
0.076	0	-	25	7
0.041	0	-	44	6
0.022	0	-	13	9
0	100	-	84	0
0	37.8	-	44	3
0	20.6	-	16	10
0	16.3	-	44	9
0	10.9	-	10	29
0	5.22	-	6	17
0.209	5.22	1:25	13	4
0.163	16.3	1:100	41	3

Beet Armyworm				
Compound 1 (ppm)	Methomyl (ppm)	ratio	% mortality (observed)	% feeding
0.076	37.8	1:500	59	1
0.041	20.6	1:500	22	5
0.022	10.9	1:500	16	8
0	0	-	0	14

Test J

For evaluating foliar control of cabbage looper (*Trichoplusia ni*), cabbage (var. Stonehead) plants were grown in Metromix potting soil in 10-cm pots in aluminum trays to test size (28 days, 3-4 full leaves). Test compounds were formulated and sprayed on test plants as described for Test I. After drying for 2 hours, the treated leaves were excised and infested with one cabbage looper per cell and covered. The test units were placed on trays and put in a growth chamber at 25 °C and 60% relative humidity for 4 days. Each test unit was then visually assessed for % mortality and % feeding; the results are listed in Table 11.

Table 11

Cabbage Looper				
Compound 1 (ppm)	Indoxacarb (ppm)	ratio	% mortality (observed)	% feeding
0.057	0	-	22	24
0.032	0	-	9	82
0	0.27	-	56	38
0	0.146	-	31	68
0.057	0.27	1:4.7	63	9
0.032	0.146	1:4.7	38	13
0.017	0.082	1:4.7	6	86
0	0	-	3	97

Test K

For evaluating control of diamondback moth (*Plutella xylostella*), cabbage (var. Stonehead) plants were grown in Metromix potting soil in 10-cm pots in aluminum trays to test size (28 days, 3-4 full leaves) the plants were sprayed to the point of runoff using the turntable sprayer as described in Test I. Test compounds were formulated and sprayed on test plants as described for Test I. After drying for 2 hours, the treated leaves were excised and infested with one cabbage looper per cell and covered. The test units were placed on trays and put in a growth chamber at 25 °C and 60% relative humidity for 4 days. Each test

unit was then visually assessed; Table 12A lists both the % mortality and % feeding results; and Tables 12B and 12C list only the % mortality results.

Table 12A

Diamondback Moth				
Compound 1 (ppm)	Indoxacarb (ppm)	ratio	% mortality (observed)	% feeding
0.030	0	-	78	0
0.013	0	-	34	2.1
0.007	0	-	13	10.0
0	1	-	50	0.1
0	0.340	-	47	0.5
0	0.226	-	25	3.5
0	0.147	-	33	13.8
0.030	0.340	1:11	56	0.4
0.013	0.147	1:11	32	4.0
0.007	0.226	1:34	30	3.8
0	0	-	24	51.9

Table 12 B

* indicates the observed % mortality is higher than the calculated % mortality by Colby equation.

Diamondback Moth	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Compound 1	0.01	87	0.02	77	0.04	93
Methomyl	30	80	40	90	50	80
Cpd 1 + Methomyl	0.01 + 30	90	0.02 + 30	60	0.04 + 30	70
Cpd 1 + Methomyl	0.01 + 40	90	0.02 + 40	70	0.04 + 40	90
Cpd 1 + Methomyl	0.01 + 50	70	0.02 + 50	70	0.04 + 50	80
Amitraz	10	70	100	20	1000	50
Cpd 1 + Amitraz	0.01 + 10	80	0.02 + 10	20	0.04 + 10	50
Cpd 1 + Amitraz	0.01 + 100	70	0.02 + 100	50	0.04 + 100	10
Cpd 1 + Amitraz	0.01 + 1000	80	0.02 + 1000	60	0.04 + 1000	60
Thiamethoxam	30	90	40	100	50	100
Cpd 1 + Thiamethoxam	0.01 + 30	80	0.02 + 30	60	0.04 + 30	90
Cpd 1 + Thiamethoxam	0.01 + 40	50	0.02 + 40	50	0.04 + 40	100
Cpd 1 + Thiamethoxam	0.01 + 50	80	0.02 + 50	80	0.04 + 50	100
Pyridaben	100	100	150	80	200	100
Cpd 1 + Pyridaben	0.01 + 100	80	0.02 + 100	60	0.04 + 100	90
Cpd 1 + Pyridaben	0.01 + 150	90	0.02 + 150	80	0.04 + 150	100

Diamondback Moth	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Pyridaben	0.01 + 200	90	0.02 + 200	90	0.04 + 200	90
Flonicamid	1	0	15	60	1000	30
Cpd 1 + Flonicamid	0.01 + 1	90	0.02 + 1	100*	0.04 + 1	90
Cpd 1 + Flonicamid	0.01 + 15	100	0.02 + 15	90	0.04 + 15	100*
Cpd 1 + Flonicamid	0.01 + 1000	100*	0.02 + 1000	100*	0.04 + 1000	90
Dieldrin	2	90	2.5	100	3	100
Cpd 1 + Dieldrin	0.01 + 2	80	0.02 + 2	90	0.04 + 2	100
Cpd 1 + Dieldrin	0.01 + 2.5	90	0.02 + 2.5	90	0.04 + 2.5	90
Cpd 1 + Dieldrin	0.01 + 3	80	0.02 + 3	90	0.04 + 3	100
Spinosad	10	100	100	90	1000	100
Cpd 1 + Spinosad	0.01 + 10	90	0.02 + 10	100	0.04 + 10	100
Cpd 1 + Spinosad	0.01 + 100	100	0.02 + 100	100	0.04 + 100	90
Cpd 1 + Spinosad	0.01 + 1000	100	0.02 + 1000	100	0.04 + 1000	100

Table 12C

Diamondback Moth	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Compound 1	0.0025	79	0.02	77	0.04	75
Fipronil	10	100	100	100	1000	100
Cpd 1 + Fipronil	0.0025 + 10	100	0.02 + 10	100	0.04 + 10	100
Cpd 1 + Fipronil	0.0025 + 100	100	0.02 + 100	100	0.04 + 100	100
Cpd 1 + Fipronil	0.0025 + 1000	100	0.02 + 1000	100	0.04 + 1000	100
Pyriproxyfen	40	100	20	100	200	100
Cpd 1 + Pyriproxyfen	0.0025 + 2	100	0.02 + 2	100	0.04 + 2	100
Cpd 1 + Pyriproxyfen	0.0025 + 20	100	0.02 + 20	100	0.04 + 20	100
Cpd 1 + Pyriproxyfen	0.0025 + 200	100	0.02 + 200	100	0.04 + 200	100
Pymetrozine	250	100	1000	100	2000	100
Cpd 1 + Pymetrozine	0.0025 + 250	100	0.02 + 250	100	0.04 + 250	100
Cpd 1 + Pymetrozine	0.0025 + 1000	100	0.02 + 1000	100	0.04 + 1000	100
Cpd 1 + Pymetrozine	0.0025 + 2000	100	0.02 + 2000	100	0.04 + 2000	100
Buprofezin	10	30	100	20	1000	60
Cpd 1 + Buprofezin	0.0025 + 10	60	0.02 + 10	40	0.04 + 10	60
Cpd 1 + Buprofezin	0.0025 + 100	20	0.02 + 100	10	0.04 + 100	60
Cpd 1 + Buprofezin	0.0025 + 1000	0	0.02 + 1000	20	0.04 + 1000	40
Chlorfenapyr	1.5	90	2.5	100	7	70
Cpd 1 + Chlorfenapyr	0.0025 + 1.5	100	0.02 + 1.5	70	0.04 + 1.5	90

Diamondback Moth	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Chlorfenapyr	0.0025 + 3.5	90	0.02 + 3.5	70	0.04 + 3.5	90
Cpd 1 + Chlorfenapyr	0.0025 + 7	90	0.02 + 7	90	0.04 + 7	90
Chlorpyrifos	10	80	100	40	1000	50
Cpd 1 + Chlorpyrifos	0.0025 + 10	20	0.02 + 10	20	0.04 + 10	30
Cpd 1 + Chlorpyrifos	0.0025 + 100	0	0.02 + 100	10	0.04 + 100	50
Cpd 1 + Chlorpyrifos	0.0025 + 1000	30	0.02 + 1000	20	0.04 + 1000	90
Cyromazine	20	60	40	90	60	80
Cpd 1 + Cyromazine	0.0025 + 20	20	0.02 + 20	30	0.04 + 20	90
Cpd 1 + Cyromazine	0.0025 + 40	80	0.02 + 40	80	0.04 + 40	90
Cpd 1 + Cyromazine	0.0025 + 60	90	0.02 + 60	90	0.04 + 60	80
Fenoxycarb	10	90	100	90	1000	90
Cpd 1 + Fenoxycarb	0.0025 + 10	80	0.02 + 10	70	0.04 + 10	90
Cpd 1 + Fenoxycarb	0.0025 + 100	60	0.02 + 100	80	0.04 + 100	90
Cpd 1 + Fenoxycarb	0.0025 + 1000	90	0.02 + 1000	60	0.04 + 1000	80
Methoprene	10	90	100	100	1000	90
Cpd 1 + Methoprene	0.0025 + 10	90	0.02 + 10	90	0.04 + 10	90
Cpd 1 + Methoprene	0.0025 + 100	90	0.02 + 100	90	0.04 + 100	90
Cpd 1 + Methoprene	0.0025 + 1000	90	0.02 + 1000	90	0.04 + 1000	90
Indoxacarb	0.02	80	0.05	40	0.4	0
Cpd 1 + Indoxacarb	0.0025 + 0.02	70	0.02 + 0.02	80	0.04 + 0.02	90
Cpd 1 + Indoxacarb	0.0025 + 0.05	60	0.02 + 0.05	90	0.04 + 0.05	90
Cpd 1 + Indoxacarb	0.0025 + 0.4	10	0.02 + 0.4	60	0.04 + 0.4	90*
Triazamate	250	90	350	60	500	50
Cpd 1 + Triazamate	0.0025 + 250	60	0.02 + 250	50	0.04 + 250	50
Cpd 1 + Triazamate	0.0025 + 350	30	0.02 + 350	60	0.04 + 350	80
Cpd 1 + Triazamate	0.0025 + 500	30	0.02 + 500	40	0.04 + 500	80
Thiodicarb	100	90	1000	90	3000	90
Cpd 1 + Thiodicarb	0.0025 + 100	90	0.02 + 100	90	0.04 + 100	90
Cpd 1 + Thiodicarb	0.0025 + 1000	90	0.02 + 1000	90	0.04 + 1000	90
Cpd 1 + Thiodicarb	0.0025 + 3000	90	0.02 + 3000	90	0.04 + 3000	90
Tebufenozide	150	90	200	90	300	90
Cpd 1 + Tebufenozide	0.0025 + 150	70	0.02 + 150	90	0.04 + 150	90
Cpd 1 + Tebufenozide	0.0025 + 200	40	0.02 + 200	90	0.04 + 200	90
Cpd 1 + Tebufenozide	0.0025 + 300	80	0.02 + 300	80	0.04 + 300	90
Deltamethrin	0.1	90	0.3	90	1	90

Diamondback Moth	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Cpd 1 + Deltamethrin	0.0025 + 0.1	80	0.02 + 0.1	90	0.04 + 0.1	90
Cpd 1 + Deltamethrin	0.0025 + 0.3	60	0.02 + 0.3	70	0.04 + 0.3	90
Cpd 1 + Deltamethrin	0.0025 + 1	90	0.02 + 1	90	0.04 + 1	80
Oxamyl	1	60	10	20	100	30
Cpd 1 + Oxamyl	0.0025 + 1	30	0.02 + 1	30	0.04 + 1	70
Cpd 1 + Oxamyl	0.0025 + 10	10	0.02 + 10	20	0.04 + 10	70
Cpd 1 + Oxamyl	0.0025 + 100	20	0.02 + 100	20	0.04 + 100	80
Hexaflumuron	0.5	70	1	30	2	70
Cpd 1 + Hexaflumuron	0.0025 + 0.5	20	0.02 + 0.5	70	0.04 + 0.5	90
Cpd 1 + Hexaflumuron	0.0025 + 1	80	0.02 + 1	90*	0.04 + 1	90*
Cpd 1 + Hexaflumuron	0.0025 + 2	70	0.02 + 2	80	0.04 + 2	90
Acetamiprid	0.3	90	1	80	3	70
Cpd 1 + Acetamiprid	0.0025 + 0.3	0	0.02 + 0.3	10	0.04 + 0.3	30
Cpd 1 + Acetamiprid	0.0025 + 1	20	0.02 + 1	20	0.04 + 1	70
Cpd 1 + Acetamiprid	0.0025 + 3	20	0.02 + 3	40	0.04 + 3	70
Cartap	100	60	1000	90	3000	90
Cpd 1 + Cartap	0.0025 + 100	90	0.02 + 100	90	0.04 + 100	90
Cpd 1 + Cartap	0.0025 + 1000	90*	0.02 + 1000	100*	0.04 + 1000	90
Cpd 1 + Cartap	0.0025 + 3000	100	0.02 + 3000	100*	0.04 + 3000	100*
Esfenvalerate	0.01	90	0.05	80	0.2	80
Cpd 1 + Esfenvalerate	0.0025 + 0.01	60	0.02 + 0.01	70	0.04 + 0.01	90
Cpd 1 + Esfenvalerate	0.0025 + 0.05	70	0.02 + 0.05	60	0.04 + 0.05	90
Cpd 1 + Esfenvalerate	0.0025 + 0.2	50	0.02 + 0.2	80	0.04 + 0.2	80
Thiacloprid	0.1	80	0.3	40	15	90
Cpd 1 + Thiacloprid	0.0025 + 0.1	30	0.02 + 0.1	20	0.04 + 0.1	80
Cpd 1 + Thiacloprid	0.0025 + 0.3	10	0.02 + 0.3	30	0.04 + 0.3	70
Cpd 1 + Thiacloprid	0.0025 + 15	90	0.02 + 15	90	0.04 + 15	90
Lambda-cyhalothrin	0.016	90	0.08	70	0.4	90
Cpd 1 + Lambda-cyhalothrin	0.0025 + 0.016	50	0.02 + 0.016	90	0.04 + 0.016	90
Cpd 1 + Lambda-cyhalothrin	0.0025 + 0.08	80	0.02 + 0.08	60	0.04 + 0.08	90
Cpd 1 + Lambda-cyhalothrin	0.0025 + 0.4	90	0.02 + 0.4	90	0.04 + 0.4	100*
Hydramethylnon	0.01	70	0.05	50	0.2	60
Cpd 1 + Hydramethylnon	0.0025 + 0.01	50	0.02 + 0.01	60	0.04 + 0.01	70
Cpd 1 + Hydramethylnon	0.0025 + 0.05	0	0.02 + 0.05	60	0.04 + 0.05	70
Cpd 1 + Hydramethylnon	0.0025 + 0.2	20	0.02 + 0.2	10	0.04 + 0.2	80

Diamondback Moth	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)	rate (ppm)	% mortality (obs)
Clothianidin	0.016	40	0.08	10	0.4	20
Cpd 1 + Clothianidin	0.0025 + 0.016	70	0.02 + 0.016	40	0.04 + 0.016	70
Cpd 1 + Clothianidin	0.0025 + 0.08	30	0.02 + 0.08	50	0.04 + 0.08	90*
Cpd 1 + Clothianidin	0.0025 + 0.4	20	0.02 + 0.4	50	0.04 + 0.4	100*
Lufenuron	0.08	80	0.4	80	2	90
Cpd 1 + Lufenuron	0.0025 + 0.08	50	0.02 + 0.08	30	0.04 + 0.08	80
Cpd 1 + Lufenuron	0.0025 + 0.4	60	0.02 + 0.4	60	0.04 + 0.4	100
Cpd 1 + Lufenuron	0.0025 + 2	70	0.02 + 2	70	0.04 + 2	100
Abamectin	0.02	90	0.08	90	0.4	100
Cpd 1 + Abamectin	0.0025 + 0.02	90	0.02 + 0.02	90	0.04 + 0.02	100*
Cpd 1 + Abamectin	0.0025 + 0.08	100*	0.02 + 0.08	100*	0.04 + 0.08	90
Cpd 1 + Abamectin	0.0025 + 0.4	90	0.02 + 0.4	100	0.04 + 0.4	100*
Methoxyfenozide	0.08	90	0.4	90	2	90
Cpd 1 + Methoxyfenozide	0.0025 + 0.08	80	0.02 + 0.08	100*	0.04 + 0.08	100*
Cpd 1 + Methoxyfenozide	0.0025 + 0.4	90	0.02 + 0.4	80	0.04 + 0.4	100*
Cpd 1 + Methoxyfenozide	0.0025 + 2	100*	0.02 + 2	90	0.04 + 2	90
Nitenpyram	30	90	75	80	150	90
Cpd 1 + Nitenpyram	0.0025 + 30	90	0.02 + 30	100*	0.04 + 30	90
Cpd 1 + Nitenpyram	0.0025 + 75	100*	0.02 + 75	90	0.04 + 75	100*
Cpd 1 + Nitenpyram	0.0025 + 150	100*	0.02 + 150	100*	0.04 + 150	100*
Pyridalyl	0.5	90	0.6	100	0.7	100
Cpd 1 + Pyridalyl	0.0025 + 0.5	90	0.02 + 0.5	90	0.04 + 0.5	90
Cpd 1 + Pyridalyl	0.0025 + 0.6	80	0.02 + 0.6	100	0.04 + 0.6	90
Cpd 1 + Pyridalyl	0.0025 + 0.7	90	0.02 + 0.7	90	0.04 + 0.7	90
Dinotefuran	1	80	2.5	60	7.5	70
Cpd 1 + Dinotefuran	0.0025 + 1	100*	0.02 + 1	90	0.04 + 1	90
Cpd 1 + Dinotefuran	0.0025 + 2.5	90	0.02 + 2.5	90	0.04 + 2.5	100*
Cpd 1 + Dinotefuran	0.0025 + 7.5	100*	0.02 + 7.5	90	0.04 + 7.5	100*

Tables 2 to 12 show mixtures and compositions of the present invention demonstrating control on a wide range of invertebrate pests, some with notable synergistic effect. As the % of mortality cannot exceed 100%, the unexpected increase in insecticidal activity can be greatest only when the separate active ingredient components alone are at application rates providing considerably less than 100% control. Synergy may not be evident at low application rates where the individual active ingredient components alone have little activity. However, in some instances high activity was observed for combinations wherein individual active ingredient alone at the same application rate had essentially no activity. The

synergism is indeed highly remarkable. Noteworthy are mixtures of the compound of Formula 1 and wherein the pest control agent of component (b1) is imidacloprid. Especially noteworthy are weight ratios of component (b) to the compound of Formula 1 in the mixtures and compositions of the present invention which are typically from 200:1 to 1:150, with one embodiment being from 150:1 to 1:50, another embodiment being from 50:1 to 1:10 and another embodiment being from 5:1 to 1:5.

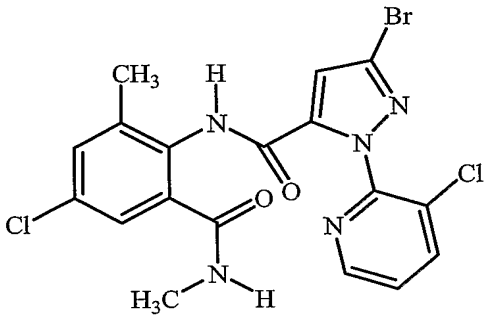
Accordingly, this invention provides not only improved compositions but also methods of their use for control of invertebrate pests such as arthropods in both agronomic and non-agronomic environments. The compositions of this invention demonstrate high controlling effect of invertebrate pests; consequently, their use as arthropodicides can reduce crop production cost and environmental load.

CLAIMS

What is claimed is:

1. A mixture comprising:

(a) a compound of Formula 1, 3-bromo-*N*-[4-chloro-2-methyl-6-[(methylamino)carbonyl]phenyl]-1-(3-chloro-2-pyridinyl)-1*H*-pyrazole-5-carboxamide, an *N*-oxide, or a salt thereof,



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and

a component (b) wherein the component (b) is at least one invertebrate pest control agent selected from the group consisting of

(b1) neonicotinoids;

(b2) cholinesterase inhibitors;

(b3) sodium channel modulators;

(b4) chitin synthesis inhibitors;

(b5) ecdysone agonists;

(b6) lipid biosynthesis inhibitors;

(b7) macrocyclic lactones;

(b8) GABA-regulated chloride channel blockers;

(b9) juvenile hormone mimics;

(b10) ryanodine receptor ligands;

(b11) octopamine receptor ligands;

(b12) mitochondrial electron transport inhibitors;

(b13) nereistoxin analogs;

(b14) pyridalyl;

(b15) flonicamid;

(b16) pymetrozine;

(b17) dieldrin;

(b18) metaflumizone;

(b19) biological agents; and

salts of compounds of (b1) through (b18).

2. The mixture of Claim 1 wherein the component (b) is a compound selected from (b1) neonicotinoids.

3. The mixture of Claim 1 wherein the component (b) is a compound selected from (b2) cholinesterase inhibitors.

4. The mixture of Claim 1 wherein the component (b) is a compound selected from (b3) sodium channel modulators.

5. The mixture of Claim 1 wherein the component (b) is selected from the group consisting of dinotefuran, imidacloprid, nitenpyram, thiacloprid, thiamethoxam, methomyl, oxamyl, deltamethrin, indoxacarb, lambda-cyhalothrin, hexaflumuron, novaluron, abamectin, spinosad, fipronil, fenoxycarb, methoprene, amitraz, chlofenapyr, hydramethylnon, pyridaben, cartap, flonicamid, pymetrozine and dieldrin.

6. The mixture of Claim 1 wherein the component (b) comprises at least one invertebrate pest control agent selected from each of two different groups consisting of (b1), (b2), (b3), (b4), (b5), (b6), (b7), (b8), (b9), (b10), (b11), (b12), (b13), (b14), (b15), (b16), (b17), (b18) and (b19).

7. A composition for controlling an invertebrate pest comprising a biologically effective amount of the mixture of any one of Claims 1 to 6 and at least one additional component selected from the group consisting of a surfactant, a solid diluent and a liquid diluent, said composition optionally further comprising an effective amount of at least one additional biologically active compound or agent.

8. The composition of Claim 7 wherein the component (b) is a compound selected from (b1) neonicotinoids and the weight ratio of the component (b) to the compound of Formula 1, an *N*-oxide, or salt thereof, is from 10:1 to 1:50.

9. The composition of Claim 7 wherein the component (b) is a compound selected from (b2) cholinesterase inhibitors and the weight ratio of the component (b) to the compound of Formula 1, an *N*-oxide, or salt thereof, is from 150:1 to 1:25.

10. The composition of Claim 7 wherein the component (b) is a compound selected from (b3) sodium channel modulators and the weight ratio of the component (b) to the compound of Formula 1, an *N*-oxide, or salt thereof, is from 50:1 to 1:5.

11. The composition of Claim 7 in the form of a soil drench liquid formulation.

12. A method for controlling an invertebrate pest comprising contacting the invertebrate pest or its environment with a biologically effective amount of the mixture of any one of Claims 1 to 6.

13. The method of Claim 12 wherein the environment is soil and a liquid composition comprising the mixture is applied to the soil as a soil drench.

14. The method of Claim 12 where the invertebrate pest is silverleaf whitefly (*Bemisia argentifolii*).

15. The method of Claim 12 where the invertebrate pest is western flower thrip (*Frankliniella occidentalis*).

16. The method of Claim 12 where the invertebrate pest is potato leafhopper (*Empoasca fabae*).

17. The method of Claim 12 where the invertebrate pest is corn plant hopper (*Peregrinus maidis*).

18. The method of Claim 12 where the invertebrate pest is cotton melon aphid (*Aphis gossypii*).

19. The method of Claim 12 where the invertebrate pest is green peach aphid (*Myzus persicae*).

20. The method of Claim 12 where the invertebrate pest is beet armyworm (*Spodoptera exigua*).

21. The method of Claim 12 where the invertebrate pest is cabbage looper (*Trichoplusia ni*).

22. The method of Claim 12 where the invertebrate pest is diamondback moth (*Plutella xylostella*).

23. A spray composition, comprising: the mixture of Claim 1 and a propellant.

24. A bait composition, comprising: the mixture of Claim 1, one or more food materials, optionally an attractant, and optionally a humectant.

25. A trap device for controlling an invertebrate pest, comprising: the bait composition of Claim 24 and a housing adapted to receive said bait composition, wherein the housing has at least one opening sized to permit the invertebrate pest to pass through the opening so the invertebrate pest can gain access to said bait composition from a location outside the housing, and wherein the housing is further adapted to be placed in or near a locus of potential or known activity for the invertebrate pest.